The

SCIENTIFIC MONTHLY

MAY 24 1948

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VOL. LXVI *June 1948* NO. 6

CHOLLA CACTUS, PALM SPRINGS, CALIFORNIA
See *The Desert Storehouse*, page 451.

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THE SCIENTIFIC MONTHLY

VOL. LXVI JUNE 1948 NO. 6

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Contents

The Desert Storehouse	*Macy H. Lapham*	451
Lines to A Skyscraper	*Laurens C. Bolles*	460
Black Butte, A Recent Subsidence Crater	*E. R. Harrington*	461
The Aurora (Verse)	*Eris Goff*	466
The *Ruppia* Balls of Little Borax Lake	*E. O. Essig*	467
Weather Is Like Wild Horses (Verse)	*Isabelle B. Longfellow*	471
Personality Classification	*Robert H. Seashore and Ward Jenssen*	472
Conflicting Doctrines About Soils	*Charles E. Kellogg*	475
For We Are One (Verse)	*Thomas P. Monahan*	487
Moses in the Laboratory	*Stella B. Cameron*	488
Contact Lenses	*Ira Lunan Ferguson*	491
Twisted Trees (Verse)	*Joseph Hirsh*	498
Advice to Newcomers	*A. J. Riker, et al.*	499
Technology and Community	*Melvin Rader*	502
Life's Greatest Evil	*Alexander F. Skutch*	514
Science on the March: Meteorites	*John A. Russell*	519
Book Reviews		523
Comments and Criticisms		531
Technological Notes		533
The Brownstone Tower		534
Index		535

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Centennial Celebration, A.A.A.S., Washington, September 13–17, 1948

The American Association for the Advancement of Science assumes no responsibility for the statements and opinions advanced by contributors to its publications. Views expressed in the editorials are those of the editor and do not necessarily represent the official position of the American Association for the Advancement of Science.

Published monthly at Business Press, Inc., by the American Association for the Advancement of Science under the direction of the Publications Committee: Farrington Daniels, J. E. Flynn, Kirtley F. Mather, Walter R. Miles, Malcolm H. Soule, and Steven M. Spencer. Office of publication, North Queen St. and McGovern Ave., Lancaster, Pa.

Orders for subscriptions and requests for change of address should be directed to the Circulation Department, A.A.A.S., N. Queen St. and McGovern Ave., Lancaster, Pa., or 1515 Massachusetts Ave., N.W., Washington 5, D. C. Four weeks are required to effect changes of address. Address all correspondence concerning editorial matters and advertising to the Office of The Scientific Monthly, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Subscriptions: $7.50 per year; single numbers, 75 cents. Copyright 1948, by the American Association for the Advancement of Science. Entered as second-class matter at the Post Office at Lancaster, Pa., December 30, 1947, under the Act of March 3, 1879. Acceptance for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Sec. 538, P. L. and R., authorized December 30, 1947.

THE
SCIENTIFIC MONTHLY

JUNE 1948

THE DESERT STOREHOUSE*

MACY H. LAPHAM

Mr. Lapham took his B.S. at Michigan State College in 1899, and then came to Washington as a scientific aid in the Division of Soils, U.S.D.A. He conducted soil surveys in California, Arizona, Montana, and North Dakota during 1901–10, when he was made a field inspector with supervision of field parties in the states west of the Rockies. In April 1944, Mr. Lapham retired as senior soil scientist and was given an appointment as collaborator.

A TRAVELER passing through the Mormon towns and settlements of Utah frequently comes upon neat buildings of brick or stone upon which may be observed the words "The Bishop's Storehouse." Here are collected and preserved the products of the near-by farms and homes, religiously contributed to the Church and held as assurance against a time of need. These stores of abundance, maintained by thrift and frugality, give to the people of the scattered communities confidence in their ability to weather a storm of adversity.

As the drier regions of the south and west are approached, the farms and settlements become even more infrequent; gray sagebrush gives way to the dark green of the creosote bush, and the shrubs and grasses of the northern plains are replaced by the Joshua trees (*Yucca brevifolia*) and smaller yuccas, rabbit brushes, shad scale, and the grasses and annuals of the Mojave Desert. Further transition to the lower and warmer Sonoran Desert of southern Arizona is signaled by a diversity of forms of thorny shrubs, dwarf trees, cacti, and other woody, succulent, and herbaceous plants. Although some of these, such as the creosote bush (*Larrea tridentata*), may cover many miles of desert slopes in almost pure stand (Fig. 1), others, differing widely in size, form, color, and in means of survival in the competition for moisture, are often intermingled in interesting and fascinating association (Fig. 2). Here the giant cactus (*Cereus giganteus*), or saguaro, which may reach a height of 30 or 40 feet and a weight of several tons, may occur next to the bushy ocotillo (*Fouquieria splendens*); together with smaller globular, segmented, or dwarf forms of cacti no larger than a man's thumb and covered with near-microscopic spines they form little cactus fairylands.

To the stranger, these desert wilderness areas seem to have little to contribute to the subsistence of the native Indian or pioneer white. In this land of desolation there is no Bishop's Storehouse to offer visible means of succor or relief. Notwithstanding this forbidding aspect, to the initiated there is revealed a veritable storehouse of the desert,

* For much of the information regarding the use made by the Indians of the plants of the desert, the author is indebted to Kearney and Peebles: *Flowering Plants and Ferns of Arizona*, U.S.D.A. Misc. Pub. No. 423, Washington, May 1942.

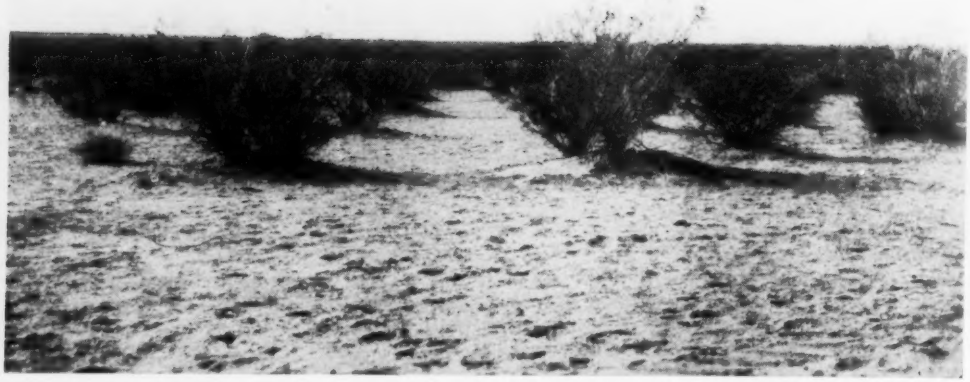

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FIG. 1. CREOSOTE BUSH (*LARREA TRIDENTATA*) IN PURE STAND

COMPETITION FOR MOISTURE RESULTS IN WIDELY SPACED HABIT OF GROWTH. FROM THE BRANCHES OF THIS PLANT THE INDIANS OBTAINED GUMS AND RESINS; FROM THE LEAVES THEY DERIVED CERTAIN DRUGS.

Photo by U.S.D.A.

FIG. 2. CREOSOTE BUSH AND OTHER PLANTS

HERE, IN CONTRAST WITH FIGURE 1, ARE INTERMINGLED THE CREOSOTE BUSH AND VARIOUS SPECIES OF CACTI, SHRUBS, AND DESERT TREES, CONTRIBUTING FUEL, BUILDING MATERIALS, MEDICINES, FOOD, AND DRINK.

from the widely scattered resources of which essentials in food, clothing, shelter, tools, cooking utensils, fuel, medicine, and articles of adornment or those sacred in ceremonial rites have contributed for generations, and still are contributing, to the needs of the Indian and the pioneering white.

Although the food resources of the desert are not always such as to tempt the fastidious, to the native Indian who knew how to find and use them they would support human life. To the white adventurers and the pioneer settlers who followed them, these resources were often the means of averting starvation. I have been told by an authority in one of the Western universities that, insofar as food essentials are concerned, it would be entirely feasible for an informed traveler to make his way on foot across the Mojave Desert, living on the country by subsisting on the seeds and other resources of the desert flora and by trapping rodents and other forms of desert life.

In essentials of human habitation, the thorny mesquites, of which there are two common species (*Prosopis juliflora* and *Prosopis odorata*), have contributed abundantly. In dry, sandy areas, where there may be no water table within many feet of the surface, this shrubby plant is forced to rely on surface moisture supplied by transient and uncertain rainfall (Fig. 3). Here the roots, developed near the surface, are greatly enlarged—frequently they form the greater part of the plant. These roots were dug from the soil to furnish a much-needed source of fuel. Today, in the vicinity of towns, they are mined with pick and shovel and sold as firewood to town and city dwellers. In the moist stream bottoms, the mesquite forsakes its desert habit of growth, develops a dual root system, and takes on the form of a tree as much as a foot or more in diameter and 20 to 30 feet in height. A system of lateral radiating roots at uniform, shallow depths is supported by the surface moisture, and a taproot extends downward many feet to the moist zone of the water table (Fig. 4). Dense thickets of this large treelike mesquite supply abundant fuel; poles and logs for the construction of huts and other shelters; materials for wooden utensils; and, in the farming and stockraising districts, fences and corrals (Fig. 5). Related thorny shrubs and treelike forms of the catclaw (*Acacia greggii*), in which the thorns are recurved, and species of mimosa, though less abundant, are used for similar purposes. The desert ironwood (*Olneya tesota*), a small tree, is known for its extremely hard wood, is prized for the campfire, and has been used in the past for arrowheads and implements.

All these plants are legumes and bear pods enclosing beanlike seeds. Both pods and seeds are eaten by livestock and have contributed extensively to the food resources of the Indians. Beans of the mesquite are made into meal and baked as cakes; at times of scarcity of other foods, they have been the main means of subsistence. The split and shredded inner bark, along with similar materials from the willow and cottonwood, furnish fibers and strands for binding and for woven baskets. Some of these baskets are so finely woven that, coated with gums and resins obtained from the desert plants, they may be used for liquids. Baskets made by the Apaches and Pimas were so enormous that they were used for storage of grain. The flowers of the mesquites and acacias and of some of the mimosas are frequented by wild and domesticated bees and are important honey-producing plants of the desert.

Cottonwoods along the stream bottoms provided firewood and building materials, and the catkins were sometimes eaten when other foods were scarce; beams and timbers of the Joshua tree have been found in ancient cliff dwellings, in localities where this plant, the largest of the yuccas and a member of the lily family, no longer occurs, indicating a former more extensive habitat. The flowers of this weird, misshapen denizen of the desert—which may be 30 or more feet high and several hundred years old (Fig. 6)—are pollinated by a moth. Plant and insect are thus interdependent. The seeds of the yucca were made into an edible meal. The buds and heads of the young flower stalks of the Joshua tree and of some of the smaller yuccas, known as the Spanish dagger or as *Candelabro de Dios* ("Candle of God"), from their upright,

Photo by U.S.D.A.

FIG. 3. SHRUBBY MESQUITE

ON SANDY LAND THE ENLARGED ROOTS OF THIS UBIQUITOUS SHRUB FURNISH MUCH-NEEDED FIREWOOD.

showy, creamy-white flower spikes, and of species of *Agave,* or century plant, and sotol, which are high in sugar content, were boiled, eaten as a salad, or roasted in pits. The pulpy fruit of the *Yucca baccata* is also reported by Kearney and Peebles to have been eaten in fresh condition, roasted, or dried for later consumption. Various species of yucca also supplied fibers for thread and materials for weaving mats and sandals. The roots of most of the smaller yuccas, when macerated in water, will serve as a fair substitute for soap, thus giving rise to the common name of soapweed. They may even have found their way into the ingredients of commercial preparations for toilet use (Fig. 7).

Nuts of the native walnut (*Juglans rupestris*), although inferior to the Eastern black walnut, were eaten; acorns from the native oaks, roasted and leached of their bitter astringent properties, ground, and baked into cakes, still form an important item in the basic food supply of many Indian tribes. Seeds of the piñon, or nut pine, especially the *Pinus edulis,* harvested from cones or pilfered from the hoarded stores of squirrels and other rodents, were highly esteemed, and the nuts are an important item today in the stock of the city confectioner and dealer in delicacies. The pine nuts and acorns supplied food for squirrels, wild turkeys, and deer. Other mammals, utilizing the oaks

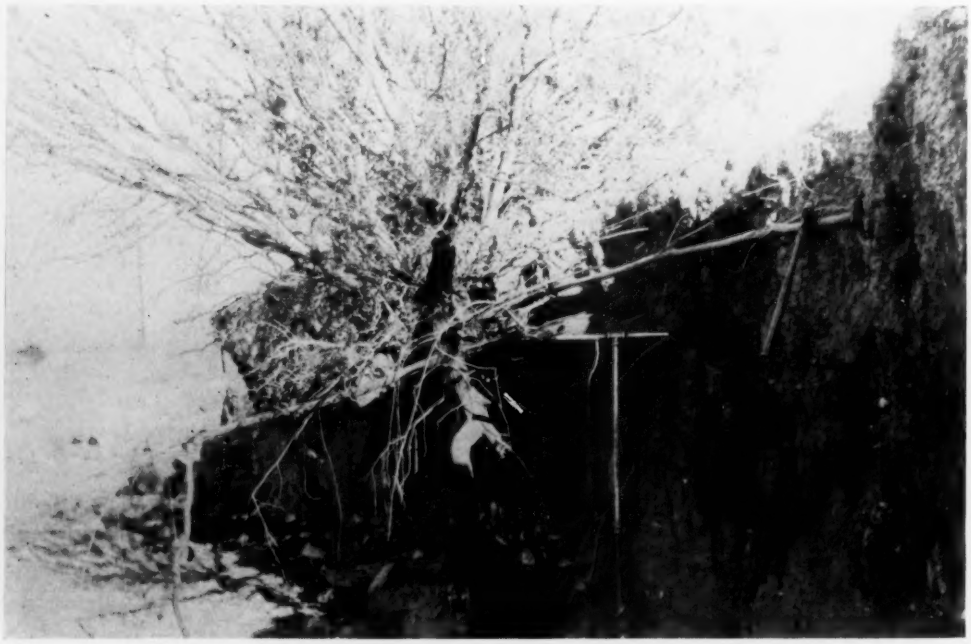

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FIG. 4. TREELIKE FORMS OF MESQUITE IN ALLUVIAL STREAM BOTTOM

LATERAL ROOTS TAKE SURFACE MOISTURE, WHILE THE LARGE TAPROOT REACHES THE DEEPER MOIST ZONE.

Photo by U.S.D.A.

FIG. 5. MESQUITE THICKET IN RIVER BOTTOM (*COTTONWOOD ON RIGHT*)

MESQUITE THICKETS SUPPLY FUEL, POLES, AND TIMBERS FOR BUILDINGS AND FENCES, AND FIBERS AND STRANDS FOR BASKETS AND BINDING MATERIALS. FROM THE MESQUITE'S BARK, SEED PODS, AND BEANLIKE SEEDS COME FOOD, BROWSE FOR LIVESTOCK, MEDICINES, GUMS AND DYES, AND AN ALCOHOLIC BEVERAGE.

and shrubs as browse, in turn entered into the food resources of the Indians.

MOST of the ubiquitous cacti are of minor importance in the economy of the Indians, but the spiny, crimson fruits of the saguaro and of the organ pipe or pitihaya cactus, are highly esteemed by the Pimas and the Papagos, who make use of them in fresh condition or as a preserve. The jars of cactus preserve form an important article of trade or barter. The fruits also contain numerous small, black, shiny seeds that are dried, ground, and baked into cakes. The red, spiny fruits of the prickly-pear cacti are also eaten by the Indians and Mexicans and are sometimes seen in city markets. Other fruits that are eaten in a fresh state, cooked, or dried by today's Indians include those of the elder, mulberry, mistletoe, wild currant, and ground cherry. Jellies and preserves made of these berries were often to be found in the larder of the early pioneer.

The trunk of the saguaro consists of a column with a tough green rind studded with spines, formed around a series of upright woody ribs, or rods. These rods, arranged in a circle enclosing the succulent, fleshy interior, are very hard and durable and remain on the ground long after the fleshy part of the plant has succumbed to decay (Fig. 8). They are used by the southern desert Indians in the supports and roofing of their flimsy dwellings. Branches and stems of arrow weed, willow, and reeds are interwoven and plastered with mud to make the unsubstantial walls that suffice under the prevailing mild climatic conditions.

The gaunt, thorn-studded stalks of the ocotillo are also a hard wood. Covered with a resinous coating that resists weathering and decay, they are especially useful in the construction of desert homes. Known also as candlewood, coachwhip, and monkeytail, the wood burns with a white flame and is highly regarded as a fuel for campfires (Fig. 9). In early spring the leafless stalks are tipped with spectacular scarlet, tubular flowers, which form one of the most attractive and fascinating floral displays of the desert. After a spring shower, the stalks become covered with small, round, scalelike

Photo by U.S.D.A.

FIG. 6. JOSHUA TREE (*YUCCA BREVIFOLIA*) ON MOJAVE DESERT

FROM THIS WEIRD, MISSHAPEN PLANT, LARGEST OF THE YUCCAS, BEAMS AND TIMBERS WERE OBTAINED FOR CONSTRUCTION OF SOME OF THE ANCIENT CLIFF DWELLINGS. THE LATER INDIANS ATE THE TREE'S SEEDS.

Photo by U.S.D.A.

FIG. 7. YUCCA FOREST IN SOUTHERN NEW MEXICO

FROM THE BUDS, YOUNG FLOWER STALKS, AND FRUITS OF SPECIES OF YUCCA ARE OBTAINED FOOD AND A FERMENTED BEVERAGE. THE LEAVES FURNISH FIBERS, AND THE ROOTS SUPPLY DRUGS AND A SOAP SUBSTITUTE.

leaves, which wither and fall away when the moisture in the soil has become depleted; these may be replaced later if showers again occur. An apparently dead and lifeless section of one of these stalks, placed in a jar of water, seemingly comes to life as the small green leaves appear. The stalks are frequently collected from the desert and set in the ground or bound together as flimsy but effective fences, which sometimes take root, thus robbing the desert of some of its natural charm (Fig. 10).

Photo by author

FIG. 8. TRUNK OF THE SAGUARO, OR GIANT CACTUS (*CEREUS GIGANTEUS*)

Right, HEALTHY SPECIMEN; *left*, DEAD PLANT. THE OUTER RIND OF THE LATTER HAS BEEN REMOVED BY DECAY, EXPOSING THE HARD, WOODY RIBS THAT ENCLOSE THE FLESHY INTERIOR. THESE RIBS RESIST DECAY TO SUCH A DEGREE THAT THEY HAVE BEEN USED BY INDIANS FOR CONSTRUCTION OF HUTS AND SHELTERS.

Species of wild beans furnish forage for livestock; one of these, known as the tepary bean, has been grown by the Papago Indians to such an extent that they became known as the "bean eaters" or "bean people." Seeds of tumbleweed (*Cycloloma*), *Suaeda*, or seepweed, and of species of saltbush and sage were parched and made into flour for mush or pinole. Various Indian tribes are reported to have used the leaves, tender shoots, and petioles of the canaigre, or wild rhubarb (*Rumex*), the saltbush (*Atriplex*), plants of the mustard family, *Stanleya*, or desert plume, mallow or cheeseweed, cow parsnip, milkweed, and dandelions as greens or as boiled vegetables.

Roots of the night-blooming cereus (*Cereus greggii*), known as *reina de la noche* ("queen of the night"), whose beautiful, heavily scented flowers last but a few hours, are reported by Kearney and Peebles to have been eaten by some Indian tribes. Roots, bulbs, and tubers of the wild carrot (*Daucus pusillus*), or rattlesnake weed, sandroot, species of wild potato, tobacco root (*Valeriana*), arrowhead, or tule potato (*Sagittaria*), and the *Brodiaea*, or grassnut, contributed to the starchy foods of the Navahos, Pimas, Papagos, and some of the other tribes.

The Indians of the southern desert, such as the Papago, Pima, Maricopa, and the Yuma tribes, were of more sedentary habit and not so skilled in hunting as the Apache, the Navaho, and other more northern Indians. These less accomplished hunters depended on rabbits, small mammals, and an occasional small Sonoran white-tail deer to add to the larder and to provide skins for

Photo by author

FIG. 9. OCOTILLO (*LEFT FOREGROUND*) AND CHOLLA CACTUS

THE GAUNT, THORNY, AND USUALLY LEAFLESS STALKS OF OCOTILLO ARE COVERED WITH A WAXY RESIN. THEY ARE SOUGHT BY THE INDIANS FOR BUILDING MATERIALS AND ARE USED FOR FIREWOOD AND FENCES.

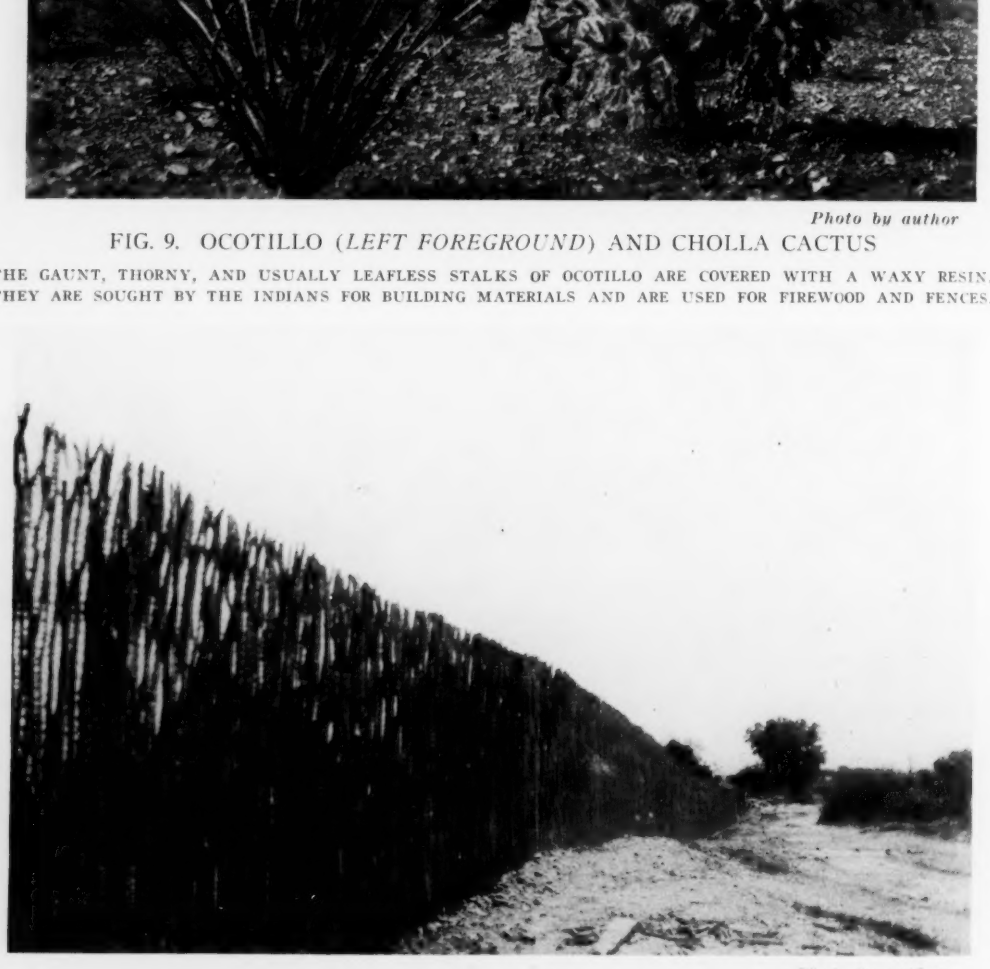


Photo by author

FIG. 10. FENCE OF OCOTILLO STEMS AND WOVEN WIRE

THE THORN-STUDDED STALKS OF THIS PLANT MAKE EFFECTIVE FENCES AND WHEN PLACED IN MOIST SOIL MAY TAKE ROOT AND GROW. MUCH OF THE DESERT CHARM IS SPOILED BY SUCH OCOTILLO FENCING.

robes and clothing. Birds that were trapped or netted included the bandtailed pigeon, wild turkey, and the Sonoran dove, the "white wing" of the sportsman. This dove often seems to call out inquisitively, "Who cooks for you?" The mule deer (larger than the white-tail), the antelope, and the desert bighorn supplied meat—some of it used in dried or smoked form—to the more skillful hunters of the mountains and northern plains. Small rodents and other inhabitants of the desert were resorted to in time of need. Of these, the chuckwalla, largest of the desert lizards aside from the sluggish Gila monster, was much esteemed by some of the Indians. This interesting animal, when pursued, secretes himself in a crevice in the rocks, wedging himself in by inflating his body, and daring the pursuer to pull him out. The Indians, however, soon learned to puncture his hide with a thorn and withdraw him ingloriously by the tail.

Even condiments and seasoning for food, before the present era of the tin can and the cellophane package, were obtained from native mints, peppergrass, sage, and other aromatic herbs. Ashes of the saltbush, which grows in saline soils, were used as a substitute for baking powder. Other plant products containing sugar and mucilaginous substances yielded substitutes for candy and chewing gum. In the absence of other liquids, the macerated pulp of the barrel cactus (from which the cactus candy of the confectioner is made) may provide a drink for the thirsty traveler.

In the fashioning of mats, nets, sandals, baskets, and in the thatching of roofs, further materials were contributed by the *Sesbania*, the tule (*Scirpus*), the cattail, and branches of various shrubs, the marsh fleabane, and reeds of the genus *Phragmites*. Split seed pods of the *Martynia pariflora*, known as the unicorn plant, or devil's-claw, formed the pattern for the black figures woven into many of the baskets made by the artistic Pimas, who excelled in making baskets of all kinds. Wild cotton was cultivated and harvested by the Indians before the white man and his wool-bearing animals found their way into the desert.

In his arts and crafts the Indian used gums and resins from the mesquite and the creosote bush as adhesives; awls made of cactus spines or sharpened bone; and dyes obtained from species of the indigo bush, sumac, mesquite, the fetid marigold, seeds of the sunflower, and from minerals. Pendants and other articles of adornment were made from fragments and beads of carnelian, garnet, topaz, turquoise, and other semiprecious stones, colored seeds, animal claws, and feathers.

In the absence of the family drugstore, the Indian and the old-timer of the desert resorted to a wide range of desert plants for cures for various ailments. Some of these were of doubtful value, but others are to be found upon the shelves of the modern druggist. These remedies included materials for poultices and infusions and decoctions of the manzanita, creosote bush, catnip, canaigre, or wild rhubard, yerba santa, or mountain balm, yerba mansa, the inner bark of the cottonwood, winter fat (*Eurotia*), golden aster, goldenrod, yarrow, horsebrush (*Tetradymia*), and species of sunflower. They were used for sore throats, coughs, respiratory diseases, boils, toothaches, fevers, sore eyes, headaches, and as tonics and emetics. Mullein leaves were smoked and used for medicinal purposes, and roots of the yucca, winter fat, and four o'clock and leaves of the seepweed were used as laxatives and for burns and stomachache. There was even an insecticide—a sweetened infusion of the leaves of the *Haplophyton*, or cockroach plant, which was used as a poison for mosquitoes, cockroaches, flies, and other pests.

The Indian drew on his environment, also, for paraphernalia for his social hours. From clay and stone he fashioned tobacco pipes, with reed stems. Mild beverages were brewed from species of sage, the young flowers and leaves of the *Thelesperma*, the *Ephedra*, or joint fir (commonly known as Mormon tea), and from seeds of the deernut or coffeebush (*Simmondsia*). More potent, alcoholic drinks were made from the roasted and fermented young flower stalks and heads of species of the century plant and the sotol, from pods of the mesquite, and from fruits of the *Yucca baccata*, the saguaro, and the pitihaya cactus.

In supplications for rain and in other sacred ceremonies of the Hopis and others, drums of hide stretched over wooden forms, gourd rattles, and reed flutes were among the stage effects; leaves and flowers of larkspur, paintbrush, and other plants to which were attributed magic powers, were smoked or otherwise employed in religious rites. Thus, as the Indian made his round of this self-help commissary in an apparently empty waste-land, he found an impressive stock to be harvested or added to his market basket. We can only marvel at the wisdom and the vast store of knowledge accumulated by these primitive peoples as they made the desert feed, clothe, and shelter them.

LINES TO A SKYSCRAPER

Preposterous pile of stick and stone and steel!
How men shall marvel, a few cycles hence,
At this gaunt hive, that now seems scarcely real,
And wonder at the strange magnificence
Of folk who, given Eden, lost their way
And ended in these cells of their own making—
Not temples, save to greed, where, souls forsaking,
They delved and schemed and hid themselves from day.

My temple is the hills, said Gabe McCord;
Its nave is cloistered by tall rows of firs.
Its choral is the birds; its Ancient Word
Comes on the evening breeze, that incense stirs
And plays soft hymns on pine boughs to the Lord.

The hills will stay when man's grim towers are gone
And sanity returns, some far-off dawn.

And so, for blasphemy in stone, Forgiveness, Lord!
Said Gabe McCord.

LAURENS C. BOLLES

BLACK BUTTE, A RECENT SUBSIDENCE CRATER

E. R. HARRINGTON

Engineer, schoolteacher, and free-lance writer, Dr. Harrington (Ph.D., University of Southern California, 1940) has been head of the Science Department, Albuquerque (N. M.) High School since 1930. In the course of his work as a consulting engineer in many Western states, he has had numerous opportunities to observe the geologic formations of which he writes.

FOR the study of basalt flows the Idaho Snake River Plain can scarcely be equaled. Here great outpourings of black lava have covered the southern third of the state, some depths ranging up to five thousand feet. The plain is a tremendous gray-green sea of sage-covered lava lapping against the south slopes of the great granite mass that forms the central Idaho mountains. This lava sea has everything! Lava flows interstratified with lake sediments, ash, dust, and gravel beds; frozen lava cascades and large areas of smooth ropy lava resembling beds of giant black snakes (geologists refer to such ropy lava as "pahoehoe"); long cracked ridges and smooth domes left by red-hot molten rock as it cooled long ago; subsurface channels still showing the flow marks along their walls; cave channels more than a mile in length; streams which flow from the mountains and vanish in the plain; water tables "perched" at a depth of fifty feet in some places and five hundred feet below the surface a mile away; caves filled with ice throughout the year; hot springs; cold springs; springs that pour from the canyon walls by the thousands; old lavas dusted over with wind-blown sand anchored by sagebrush; islands of lava that may have been poured out within the recent centuries; great jumbled masses of angular lava fragments known to geologists by the Hawaiian name of "aa"; steep-sided cones built up of volcanic ash, froth (called scoria), rounded "bombs," and viscous lava; great flows so fluid that they left no certain indication of the fissures from whence they came; and so on and so on. Whatever volcanic flow characteristics are sought, the Snake River Plain will come close to furnishing them: old flows dating back millions of years; new flows less than a thousand years in age. Name it, and the Idaho lava plain can show it.

BLACK BUTTE IN IDAHO

THE SHADED RECTANGLE AROUND SHOSHONE LOCATES THE VOLCANIC BLACK BUTTE AREA IN THE STATE.

To the student of geology, all the flows, both young and old, will be of interest. To the casual observer, the recent flows will stand out more sharply and attract the most attention. To the visitor who wishes to observe the new and see where it meets the old, the Black Butte area offers the ideal position.

The great outpourings of Idaho's black lava (basalt) began back in Eocene times, considered by the geologist as recent, although

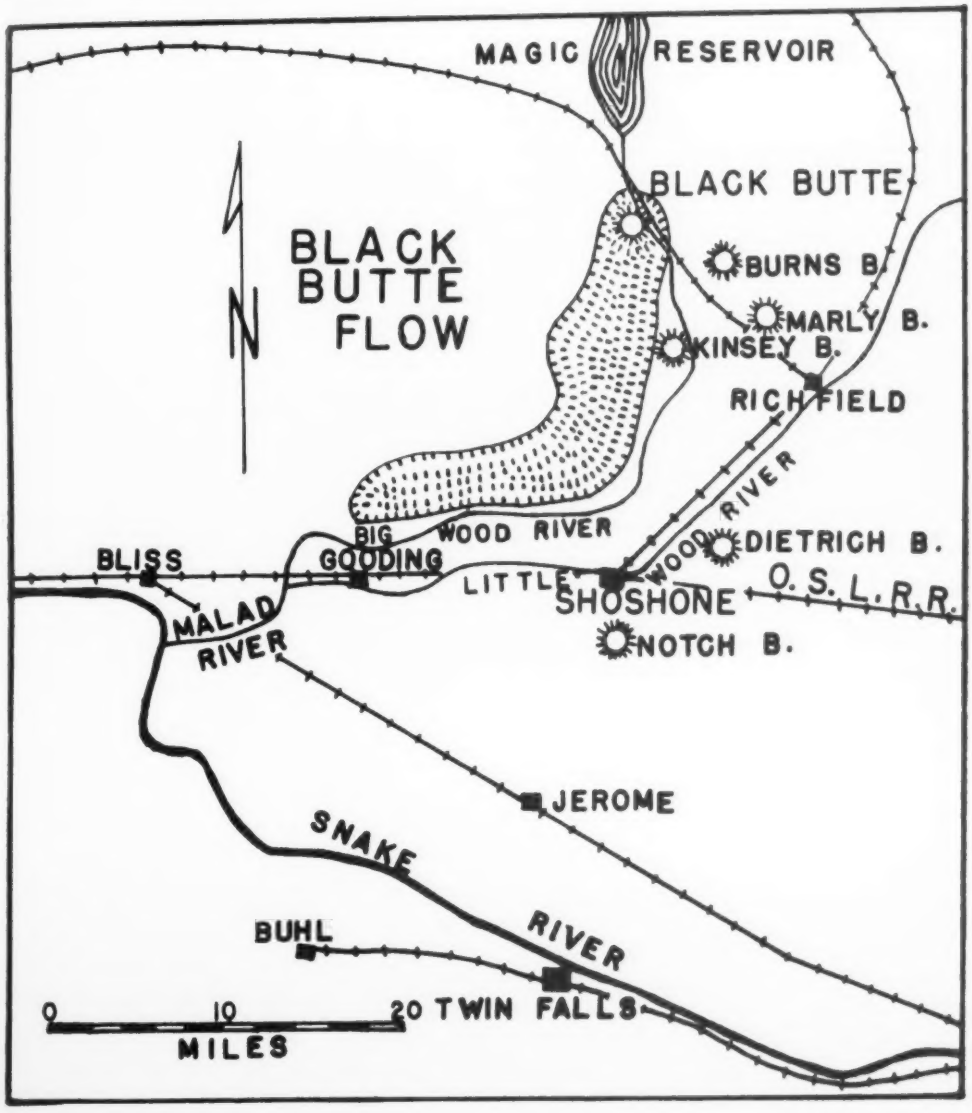
they date back more than thirty millions of years. The lava flows have continued, intermittently, almost down to the present century. Through a considerable area of the Plains the basalt is so fresh that it preserves all the surface features associated with flows that have been poured out within the past thousand years. Soil is largely absent in such areas, and the same can be said of water. Washington Irving, in his *Adventures of Captain Bonneville,* describes one of these areas as "A place where nothing meets the eye but a desolate and awful waste, where no grass grows nor water runs and nothing is to be seen but lava." This special quotation might have referred to the Craters of the Moon region near Arco, or it might have referred to the Black Butte flows mentioned here. Stearns estimates that the Craters of the Moon activity dates back 250 to 1,000 years, and the Black Butte flow has the same apparent age.

The Black Butte flow is a large black island resting on the sea of older lava. To the east and south a number of broad, flat cones show some of the sources of the older lava. The Dietrich Butte east of Shoshone is representative of this class. Its great flat cone is fifteen miles in diameter at the base, four hundred feet high, and capped by a subsidence crater three hundred feet deep and a mile in diameter. The crater floor is covered deeply by fine, wind-borne sand, or "paloose," more than 90 percent of which is as fine as wheat flour. Notch, Marley, Kinsey, and Burns buttes are similar cones, and there are numerous less prominent ones that mark vents through which the lava once poured.

Big Wood and Little Wood rivers rise in the central Idaho mountains and flow across the lava plain, joining for their last ten miles to form the Malad River, the only surface stream to reach the Snake River from the north in a distance of three hundred miles. Other streams have made the start, only to become "lost rivers" when they reached the porous lava plain. The Wood rivers carried through in part because of their strength as flowing streams, but chiefly owing to the fact that through most of their course they flow in comparatively well-established channels,

BLACK BUTTE AS SEEN FROM THE OLDER LAVA ON THE EAST

THE CONE IS LOW AND BROAD, A CHARACTERISTIC OF BASALT, WHICH IS A VERY FLUID LAVA.



BLACK BUTTE AND ITS LAVA FLOW

which have been silted up through many centuries of flow. The older basalt areas traversed by the streams are well dusted over with soil in most places, and extensive farming acreages are irrigated from the streams. In the lava areas where the soil is too thin for cultivation or the land is too high to be reached by irrigation water, the lava is well covered by hardy grass and the inevitable sagebrush (*Artemisia tridentata*).

The Black Butte crater is fifteen miles due north of the town of Shoshone, Idaho. The basalt that issued from the cone followed the course of the Big Wood River, crowding it from its former bed and forcing it to cut a trench along the flow's edge. In many places the lava is cindery, frothy, and filled with gas bubbles. Gas bubbles more than two feet in diameter are common. The Big Wood River has made use of these pockets in cutting down its bed. The stream pebbles have ground out the gas pockets, forming large potholes, and at places the stream channel is fifty feet deep, though only four feet wide at

A PRESSURE DOME IN BLACK BUTTE CRATER

the top. The newly formed channel has not silted up appreciably, and the water loss is tremendous, amounting to half the peak flood in one section of three miles. The local irrigation company has built a by-pass around the recent lava section to avoid the excessive loss of water. In the older basalts above the Black Butte flow, the Big Wood River has cut a wide and deep canyon, which is well silted up, and here the water loss is small.

The Black Butte cone rises about four hundred feet above the old lava plain. Its broken top is surmounted by an irregular crater a mile long and half a mile wide. The crater is the perfect example of a recent volcanic subsidence. The final withdrawal of

CHANNEL OF THE BIG WOOD RIVER THROUGH THE BLACK BUTTE FLOW

material left the inner crater "well" with nearly vertical sides and a flat, ropy floor broken only by a few small necks and domes.

The north rim of the crater is notched by a U-shaped ditch twenty feet wide and six feet deep. This ditch runs for more than half a mile down the north side of the cone. Evidently, for a time, the huge crater was filled with molten lava, and a part of it coursed down the north side, forming this well-defined ditch in which the flow lines are as fresh today as if the flow had taken place a few days ago. Two other less well-defined ditches also led small flows of lava down the north side of the crater. On the east side of the crater a small break a hundred feet below the rim flowed for a time and built up a small parasitic "spatter cone." The crater rim is made up partially of red, frothy scoria and a thin, platy lava mixed with volcanic ash, blobs, and bombs.

LAVA DITCH ON THE NORTH SLOPE OF BLACK BUTTE

The largest part of the lava went to the south, passing through a channel below the surface of the advancing flow. This lava tube has now fallen in, forming a wide, ragged ditch that can be followed for several miles from the butte's base. At one point a mile from the crater, a portion of the channel roof has remained in place to form a natural bridge across the depression crack. It is apparent that this channel was the outlet that finally drained the Black Butte crater. As the lava subsided two hundred feet or more inside the crater, large rockfalls slid down the nearly vertical crater sides. As these rockfalls slid to the crater bottom, they cut grooves in the pasty lava walls or, in places, smoothed out the congealing lava into slick slides.

Today a view from the south rim of the Black Butte crater will show the larger part of the great flow curving to the south and west. To the east lie the irrigated fields of the Big Wood River Valley. To the west the older sage-covered basalt extends to the horizon. Between the valley and the old plain the recent lava lies like a great crescent-shaped splash of India ink.

A number of older underground channels are found in the lava along the western side of the recent flow. One of these channels in the older lava is occupied by the Shoshone Ice Cave, now a National Monument.

The Black Butte flow is traversed by a road to the Ice Cave, but no road leads to the crater itself. A rocky road to the Magic

Reservoir does lead along the north rim of the flow, and the crater rim is best reached from the north side by walking up the lava ditch previously mentioned. The lava is cracked and broken, and its knifelike edges are very hard on shoes. Depression cracks and irregular lava blocks make detours necessary in places, but when the traveler reaches the crest he gets a real view.

From his vantage point the visitor need not be a "rock detective" to read the story. He can see the old lava plain as it was before the eruption of the Black Butte. He can visualize the formation of the crater from a small, active vent and watch it as it builds itself up above the old plain. He can imagine the crater as it was at the height of its glory when it was brimming full with a white-hot lake of lava a mile in diameter. In his mind he can see the white-hot lava splash across the north rim and pour down into the valley of the Big Wood River. He can all but hear the steam explosions as the hot lava poured into the stream channel to impound the water into a boiling lake. Finally, he can see the great lava tube open to the south and build up a huge red-and-black smoking crescent thirty miles long. On the north side of the crater the Big Wood River is already picking its hissing way across the smoldering rock dam. The crater is drained, the volcano dead.

When did the volcano die? Maybe it was a thousand years ago. Maybe it was only two or three hundred years ago. The visitor cannot determine the time, but the story is there for him to read. All he needs to do is to climb the north rim and look about him. Black Butte is without doubt one of the best examples of recent volcanic activity in the United States.

THE AURORA

The sun spouts forth small particles
Sprayed like gigantic streams that trace
Vast, awesome, and electrified,
The realms of space.
Through millions on millions of miles
From this great, whirling soul of day,
The vast light sprinkler, arcing wide,
Rotates our way
Drawn by Earth's own magnetic fields
Where atoms, clashing, give off light
And spill their startled glory's tide
To rainbow night
Like some strange shoreless, burning sea
Swept from the sands of Eternity!

ERIS GOFF

THE RUPPIA BALLS OF LITTLE BORAX LAKE

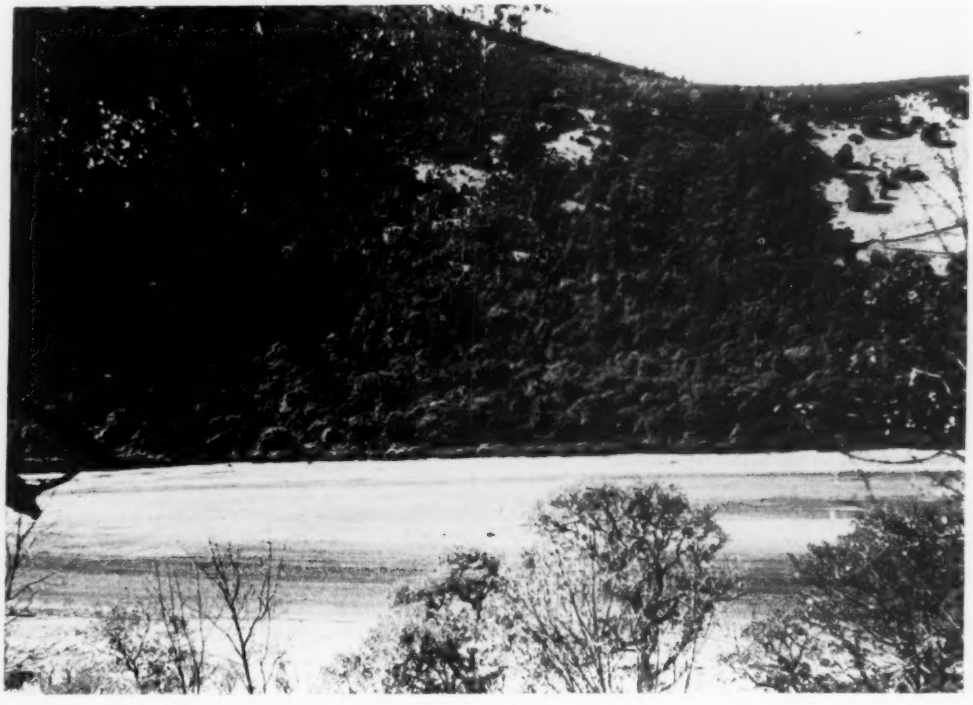
E. O. ESSIG

After taking his M.S. from Pomona College in 1909, Professor Essig spent a year as horticultural commissioner of Ventura County, California, and three years as secretary of the California State Horticultural Commission. In 1914 he became assistant professor of entomology at the University of California (Berkeley) and he is now chairman of its Division of Entomology and Parasitology.

ON July 5 last, A. A. Trippel, of Nice, Lake County, California, brought to my office several strange-looking balls which had been collected on the shores of Little Borax Lake. These balls were regularly oval in shape, gray in color, and appeared to be composed of a hairlike substance. The collector furnished the following information concerning them:

1. They had not previously been noted in the country even by the Indians or the oldest white inhabitants.
2. They occurred on the shores of this particular lake (when it had dried up) in great numbers—perhaps thousands.
3. They varied in size from a baseball to a small watermelon; in shape they were regularly oval, though a few of the smaller ones were spherical.
4. Their composition was unknown and could not be accounted for.
5. Some of them, certainly, were too large to be stomach hair balls, or aegagropilae.

A cross section of the balls showed an even, closely packed matrix of small, stiff, woody, needlelike fibers nearly uniform in length. These hairlike strands were so tightly and intricately interlaced as to constitute an almost indestructible whole. Yet there was no evidence of any adhesive binding the innumerable bits together, and no obvious core which might have furnished the



LITTLE BORAX LAKE

RUPPIA BALLS ALONG THE EASTERN SHORE LINE

THIS PICTURE WAS TAKEN FROM THE LAKE BOTTOM AND LOOKS SOUTHEASTERLY.

A CLOSER VIEW OF THE *RUPPIA* BALLS

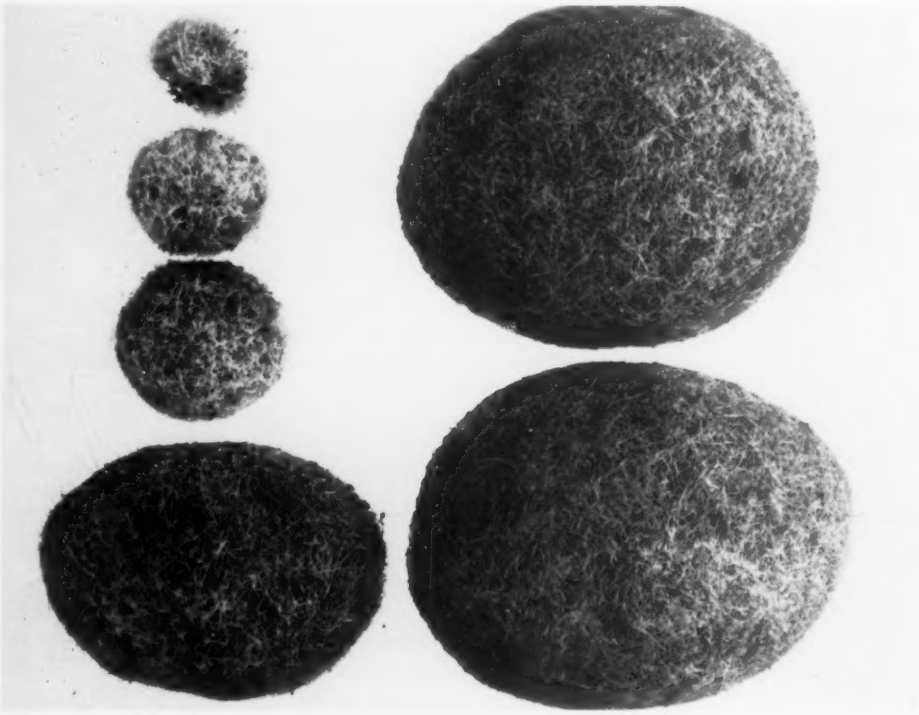
ABOUT HALF TOTAL NUMBER ARE SEEN, WITH THE LAKE BOTTOM AT THE LEFT.

beginning of the balls. It was evident, however, that the balls had been enlarged gradually, because formations as small as one inch in diameter were subsequently discovered. A few balls, opened later, revealed leafy tissues throughout the matrix, and even slight cavities.

A microscopic examination at once disclosed the true nature of these mysterious balls. The small, hairlike filaments were, in fact, plant material. Many of them terminated in an enlarged black, round seed pod, with a pointed end. Specimens were submitted to Dr. H. L. Mason, professor of botany at the University of California, who identified the plant as *Ruppia maritima* L., commonly called "ditch grass." The balls appeared to be composed almost entirely of the small seedstalks and, possibly, broken stems of this plant.

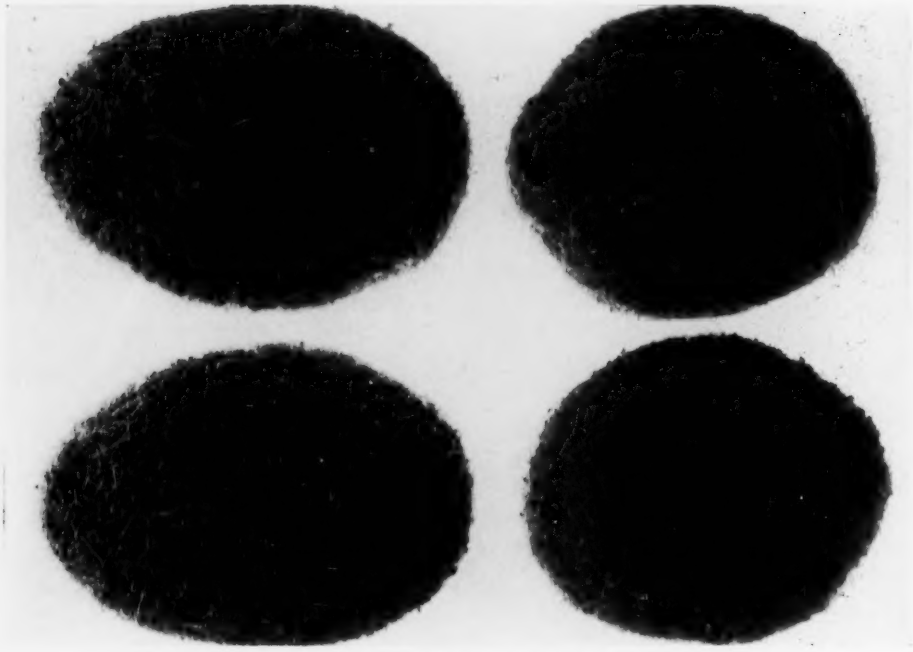
Ditch grass grows in brackish or salt water and is widely distributed throughout the Northern Hemisphere. Along the Pacific Coast it occurs from British Columbia to southern California. It is an odd plant, having greenish-white branching stems and threadlike leaves. It grows in large masses, which break apart and float about in the water.

The desire for more information concerning the origin of the balls, especially the manner in which they were formed, led me to visit Little Borax Lake, which lies at the foot of Mount Konokti, between the mountain and Clear Lake. The trip was made on October 12, just after an inch of rain had fallen in the area. The brackish water of "Borax Pond" (as it is sometimes called) ordinarily does not overflow; it therefore varies from slight alkalinity during periods of heavy rainfall (average annual rainfall for Lake County is 28.51 inches) to heavy salt



SPECIMENS OF *RUPPIA* BALLS

THEY VARY IN SIZE FROM A BASEBALL TO A SMALLWATERMELON AND ARE GENERALLY OVAL IN SHAPE. THERE IS EVIDENCE THAT SOME OF THESE BALLS MUST HAVE BEEN ON THE SHORE OF LITTLE BORAX LAKE FOR MANY YEARS, FOR GREAT NUMBERS—PERHAPS THOUSANDS—WERE FOUND IN VARIOUS STAGES OF DECAY.



CROSS SECTIONS OF TWO *RUPPIA* BALLS

SHOWN HERE IS THE EVEN, CLOSELY PACKED MATRIX OF STIFF, WOODY, NEEDLELIKE FIBERS. THESE HAIR-LIKE FILAMENTS, SO TIGHTLY AND INTRICATELY ENMESHED, FORM AN ALMOST INDESTRUCTIBLE WHOLE.

concentrations just prior to complete evaporation. The lake is small, almost circular, and approximately a quarter of a mile in diameter. Normally, there is not much more than four feet of water over the saucer-shaped bottom. At the time of my first visit, it was possible to walk across the exposed bottom, which in spots was covered with a thin layer of decomposed vegetable matter. This deposit, wetted by the rain, had about the same consistency as fresh cow manure and a rather offensive odor. This decaying plant residue indicated clearly that there must have been vegetation growing in the water at the time the lake dried up. I visited the lake again on January 18, 1948, at which time probably one-fourth of the bottom was covered by water. The mud did not permit an examination of any life that may have started. Decayed *Ruppia* appeared in a strip extending about one hundred feet from the upper edge of the shore line toward the middle of the lake, and was limited to the eastern shore.

On the cracked soil of the bottom, there were remnants of aquatic animal life, especially of the larvae and pupae of the so-called Kootsabe fly, *Ephydra hians* Say, which occurs elsewhere only in Mono Lake, Owens Lake, and East Lake, all of which are east of the Sierra. This fly has lived in Little Borax Lake for years. For this reason, it seems obvious that the adults must survive when the lake dries up, which has surely happened many times in past decades.

The *Ruppia* balls were mostly near the high-water mark on the eastern shore. In this same area, grasses were green and growing well, whereas everywhere else around the margin of the lake the banks were dry and devoid of vegetation. The prevailing winds may have come from the west and washed the balls onto the east shore.

It seems likely that the balls were formed by the loose *Ruppia* plants being rolled by wave action on the broken remnants of plants along the shallow shore line until the compact, almost indestructible masses were shaped,

and that they were rolled up along the shore line only at high water. A close examination of the eastern shore of the lake revealed a great thick mass of small particles of the *Ruppia* plants imbedded in a matrix of decaying material. This would seem to indicate that only a very small amount of the available material was actually being shaped into these remarkable balls. The inexplicable thing was that practically all the balls were deposited in a relatively restricted strip not more than four to six feet wide. (This might possibly have been caused by a particularly violent windstorm when the lake was nearly dry.)

There was plenty of evidence that some of these balls must have been on the shore for many years, because countless numbers in different stages of disintegration were noted throughout the area.

WEATHER IS LIKE WILD HORSES

How can we hope ever to bring them in—
Black stallions from the mountains of the moon,
White mares that pasture down the Pleiades,
Or their fleet young of tapping, crystal hoof,
Dashing in silver herds across the roof—
How can we hope? Space, the unconquered range,
Rolls past surmise, and there are bars that hold
Against all capture. O they may even come,
Their quivering nostrils stilled one sudden hour,
Nuzzle a soft nose in a hand, their power
Seemingly broken, but surely as we cross
To claim their invisible tethers and voice for truth
Their courses one turn hence, then will they stiffen,
Rearing against all forecast, the erstwhile tame,
Foam-flecked and thundering through crackling whips of flame!

ISABELLE BRYANS LONGFELLOW

PERSONALITY CLASSIFICATION AND COUNSELING TECHNIQUES

ROBERT H. SEASHORE and WARD JENSSEN

A specialist in the classification of experimental methods, Dr. Seashore took his Ph.D. in psychology at the University of Iowa in 1925. He has taught at Ohio State, Stanford, Southern California, Oregon, and at Northwestern, where he is now chairman of the Department. Mr. Jenssen is a graduate student at Northwestern specializing in personnel work.

PSYCHOLOGISTS have suggested a number of methods for classifying the so-called personality characteristics. Kretschmer, for example, has proposed a system of parallel physical and psychological types (the tall, slender man tending to be reclusive and self-contained, etc.), and Jung has offered the well-known extroversion-introversion scale as a basis for personality classification. Other systems may be even more familiar to the reader—handwriting analysis, interest inventories, and neurotic symptoms, to name but a few; there are many, some more scientifically sound than others.

A new method for the description of individual differences in personality is offered in this article; that is, the classification of personality factors in terms of what a person does in meeting common problems of everyday life. To the phrase "Life is a series of problems," might be added "And by one's temperament we mean the characteristic ways in which we meet those problems." Many of them we are able to cope with easily; others take more time and effort; some are never satisfactorily solved.

Since our theme is "problem-solving behavior in conflict situations," it might be well to define what we mean by this. By the word "conflict" psychologists mean the situation that arises when a person (or group) proceeding toward a goal meets an obstacle which hinders progress toward that goal and which does not yield to ordinary ways of overcoming it. A few other definitions may be helpful:

Goal: something satisfying a physiological drive (hunger, etc.) or a learned social motive (approval, etc.).

Obstacle: A competing physiological or social motivation (background stimulation) or an environmental factor (person or thing; even imaginary things) or the lack of something.

Frustration: A condition in which ordinary problem-solving methods have failed, but continuing or recurrent strong motivation forces the person to persevere in his search for a solution; often results in highly emotional (unorganized) behavior, which lasts until an efficient solution is hit upon.

WITH this background, then, let us consider the following examples, which portray the types of behavior common in frustrating situations. Imagine five men, all striving for the same goal, all faced with the same obstacle. The usual problem-solving methods having failed, each man turns to a different type of behavior with which to meet the conflict.

The first man may employ what is known as the "direct attack"—the most probable reaction. His is a habitual approach, with two possible variations: he may continue toward the goal, compensating for his difficulty by added effort, but still applying his original approach even though it has previously failed; or he may compensate by an improved method of approach, evolved by trial and error or some other means that has pointed to a better way.

Man No. 2, perhaps, utilizes the "flank attack"—a detour toward the original goal. Rather than attempting to break through or surmount the obstacle, as the first man is doing, this man *goes around* the obstacle by a circuitous route.

The third man, let us say, turns to "es-

cape." Since no method of overcoming the difficulty is apparent to him, he simply gives up any active attempt to solve it and diverts his energy into other directions. He does this either by denying the very existence or importance of the problem, thus ridding himself of it, or he stalls for time with the hope that something will happen to relieve him of the necessity of doing anything further.

Our fourth man, finding himself blocked, applies the "diversion" method. He diverts his attack from the pursuit of the original goal to either aggression against the *difficulty*, as an end in itself—a largely emotional outburst as a relief from tension during frustration—or he distracts his own attention or that of others from the difficulty by drawing a red herring across the trail.

Our last man compromises—he applies the method termed "partial solutions." Unable to solve his problem, he resorts to an attempt to deal with one or more *parts* of it. There are a number of partial-solution mechanisms to which he may turn. The importance of understanding these mechanisms lies in the fact that they are the common *partial* solutions hit upon by people in difficulty. They are, therefore, descriptions of alternative courses of action for situations in which direct analytic approaches are either not known or too expensive in time and energy.

Common among these alternative courses are:

1. Rationalization—distorted reasoning about the problem.
2. Substitute activities—redirecting motivation into other channels.
3. Identification—joining the company of persons who do succeed and basking in reflected glory.
4. Projection—putting the blame for failure on some other person or thing.
5. Regression—reverting to the role of a younger, less experienced, or invalid person who could not be expected to solve the problem.
6. Fantasy—daydreaming imaginary solutions in a dream world instead of facing realities in the situation.
7. Overcompensation—developing motivation for original problem far more than is necessary.
8. Dissociation—formation of logic-tight compartments; splitting up the problem and dealing with one or several parts separately.
9. Egocentrism—getting some kind of personal attention, even if unfavorable.
10. Sympathism—getting someone else to assist with the problem, or at least to pay some attention to you if you fail yourself.
11. Negativism—refusing to act at all, or being contrary about the problem.
12. Repression—inhibiting overt activity by directing motivation to implicit activities, thinking and visceral (emotional) activity.

Our five men do not always retain their individual methods; finding one solution unsatisfactory, perhaps, they shift places, jumping about from one procedure to another until they find peace of mind. Further, no one method is appropriate for all situations. The objective of a well-adjusted person should be to use each method in the particular situation for which it is especially suitable, changing his type of approach as the problem itself changes.

The methods of solution that we devise to meet problems as they arise are a very direct manifestation of our individual personalities. The ways in which we attempt to meet our problems largely determine our success in solving them, and thus determine to a great extent how well we win social approval or vocational effectiveness. Two persons will rarely solve the same problem in the same way, and it is rare, too, that a single individual is able to solve all his problems by the same method.

Does it not seem logical, then, to base the identification of our personalities on our own pattern of problem-solving methods? The old concept of personality "types" really did much the same thing except that its protagonists failed to recognize the wide and practically continuous variations between the diversified patterns of problem-solving approaches that they called the symptoms of a syndrome; they failed also to realize that these patterns of mechanisms are not determined by the individual's temperament, but that they *are* his temperament.

What is the significance of this system of classification? Would the establishment of such a system be an aid to the counselor in his work? The authors have employed it in several ways, the simplest being discussions designed to assist students of elementary psychology in planning a career. These students were asked to describe what they would like to achieve in each of five areas of

endeavor: education, vocation, avocation, leadership, and personal development. It was found that they could do this fairly easily, particularly when they were urged to set goals for which they would really be willing to work if they thought there was some reasonable possibility of success. After listing the advantages and handicaps they possessed for achieving each of the five goals, they were asked to describe what methods, if any, they had employed up to the present time to achieve each goal. If these did not appear productive of the desired results, they were then asked to examine the classification for alternative methods that might overcome the difficulties so far encountered.

This procedure is being elaborated by Dr. A. C. Van Dusen, of Northwestern University, in the form of a booklet designed to assist a student or his parents in formulating his plans for a career as far as possible before seeking expert assistance (where needed). This is based on the idea that the formulation of a problem is often more than half the process of solution, and that a systematic method of procedure may save both the student and his advisers a great deal of time.

Another collaborator, Dr. Eileen Sinclair, has employed the same general approach to problem solving for girls confined in an institution for juvenile delinquents. She, also, began by having the girl formulate the problem that had produced her difficulties, and then analyzing what she did to meet the situation. Obviously, this involves the building up of rapport with the psychologist, and the process of talking over the problem has the usual benefits of mental catharsis. It goes beyond this, however, in attempting to give the girl a clear understanding of the new situations she will have to face upon parole, and in the selection and development of problem-solving methods for dealing with each such situation.

Perhaps the most important factor of this system of classification for clinical psychology is the fact that it attempts to analyze personality characteristics in terms of *habitual methods of responding to the principal types of situations every person faces*. The end result should be an individual profile of the extent to which a person employs each main type of problem-solving method in dealing with his major problems.

An analogy might be drawn between this method of counseling and the work of the motion-study expert. Consider two drill-press operators; both men perform exactly the same job on identical machines, yet the output of one is many times greater than the output of the other. A motion-study expert is called in to analyze the job, and he finds that the slower man is using the wrong work method—the wrong approach to the problem. How easy it is for the expert to spot the wrong method and to correct the operator, thus making the job considerably easier and at the same time increasing the output.

The same thing applies to the counselor—with a knowledge of the classification of problem-solving behavior, he can steer his troubled client out of the frustrating situation in which he has placed himself.

The fact that such a classification is not a static one is perhaps one of its most hopeful features; it breaks down such large and vague concepts as "social maladjustment" into smaller categories and offers methods by which an individual can attack the particular problems in his social situation. It goes beyond diagnosis and places emphasis on the provision of technical abilities for assisting the individual to deal with his problems more adequately.

Both the consultant and the client can contribute actively to such counseling, and if the alternative methods of problem solving are made clear, there is greater probability of the client being able to develop skill in his methods of handling future problems himself, or at least becoming able to recognize when he requires expert assistance. In either case, this type of diagnosis tells him what he is doing that is inadequate in a given situation and suggests a complete classification of the various alternative methods he might employ. Changing to another method of approach is the principal means of getting out of a rut and onto the path toward solution of the problem.

CONFLICTING DOCTRINES ABOUT SOILS

CHARLES E. KELLOGG

Dr. Kellogg (Ph.D., Michigan State, 1929) served as research assistant in soils at Michigan State during 1925–26 and studied on a fellowship there until 1928, when he became a soil scientist for the Wisconsin Geological and Natural History Survey. He taught at the North Dakota Agricultural College from 1930 until 1935, when he was made chief of the Division of Soil Survey, U.S.D.A.

THE general public has recently discovered soil. For centuries country people have known soil—their own kind of soil. They have loved it, cursed it, sweated over it, and died for it. Their knowledge passed on from parents to children over the years. Also, a few early scientists studied soil, but only a few prior to about 1900. There was another thirty years before the public generally became deeply interested.

This is not to say that no scientific studies of soils began before 1930—not at all. The work of the famous Rothamsted Experimental Station in England, devoted mainly to soil study, was begun in 1843. The great Russian school of soil science originated about 1870. The American Soil Survey will be fifty years old in 1949. Most state experiment stations in the United States were making some soil studies by 1900, and several considerably before that date. But public support was meager. Much of the work consisted of simple tests directed toward immediate goals of increasing crop yields. But not all of it. A few investigators did raise fundamental questions: What *is* soil? Why are soils so unlike the rock beneath them? Why do soils vary so much from place to place? What accounts for their productivity for plants? Why are some good and remain good while others deteriorate?

The practical results of this work have more than paid for the cost—many, many times more. This was always expected. Yet it is a strange thing, perhaps, that people have recognized the cultural value of fundamental scientific research in what might be called the more "classical" sciences, such as astronomy, botany, or physics, and support such research generously without the promise of immediate practical returns, but rarely will they do this with fundamental soil science. Soil research must promise in advance to pay its way in the garden, field, or forest, and soon. But any scientist knows that applied science cannot get very far ahead of fundamental science.

Today people in the city as well as in the country are concerned about soil. They have been persuaded that the security of our country depends upon how our soils are used. Although we have had bad gullies for more than a hundred and fifty years, only a few people saw them before. Now what should be done? Questions are asked about world soil resources. That is, is the area of productive soils in the world large enough to feed all the people even if, by some miracle of statesmanship, the economic and political barriers to use could be removed? And what of the quality of our foods grown on different soils, and with different chemical fertilizers? Is it getting poorer? Gasoline motors are replacing horses. Can soil be kept productive without animals? Do we plow too much with the new machines?

In highly emotional terms, many popular books and magazine articles of the middle and late thirties stressed the catastrophic dangers of soil neglect. Some even asserted that soil deterioration was a primary cause in the decline of older civilizations. Most of these advanced some panacea, usually a simple cure for the "simple" problems. But since there were several panaceas, at least some of them must be partly wrong. Then, too, the soil is anything but simple, to say nothing of the people who live on it.

These trends continue—many panic makers and corrective panaceas. But the public is becoming a bit wary and demands more

detail. For one thing, the experiences of victory gardeners helped. City people took the opportunity to try managing a soil. Panaceas were put to test. Many found that although soils may be stubborn or yielding, they are rarely simple. American farmers increased enormously their use of scientific principles during the past war. All this demand for specific facts and principles is good, even though many answers are still wanting; for the first step toward wisdom is an awareness of something to be known.

LET us look at a few of the current doctrines about soils, remembering when we do so that each has some basis of important fact and that many of the advocates of each are well intentioned and sincere. Correct appraisal is made difficult by the extremists. Any good idea, good in its relationship to other good ideas, can become bad, even vicious, when carried to absolutism. Then, all of us are likely to have at least some prejudices, possibly unconscious ones, hard as we try to avoid them.

The balance-sheet theory. We may start with the balance-sheet theory—the-soil-is-like-a-bank idea. This doctrine is not new. Quite the reverse. It was clearly stated by the great German chemist Justus von Liebig nearly a century ago.

In reaction against the more or less mystical notions that plants can change one element into another and so on, he explained the sources of plant nutrients in straightforward terms of the new chemistry. Plants require certain nutrients from the soil: calcium, nitrogen, potassium, and the like. If we analyze the soil and find what it contains, then, knowing the need for crops, we can calculate how many crops can be grown or what fertilizers to apply. With sarcasm and invective, Liebig swept away notions of plants feeding directly on humus or changing one element to another. Crops will grow, he said, in direct proportion to the increase or diminution of the nutrient elements in the soil. He re-emphasized the law of the minimum: where several factors are essential, plants will grow in direct proportion to the least favorable one—the limiting factor.

Just before his death, Liebig became unhappy over his theory. For one thing, his fertilizers were not successful. Then he went down the Danube Valley and saw soils which, according to his reckonings, should have long been sterile, but which were producing more than before, without fertilizer. Nor could he account for the nitrogen in certain plants. This last failure was nearly a deathblow, but with the discovery of nitrogen-fixing bacteria growing on the roots of legumes, the theory recovered. Thus, it is curious that a biological discovery saved the day for a purely chemical theory.

Many people believe this theory. And why not? It is so simple and so reasonable. That is, it would be if the implied concept of soil were true.

Neither Liebig nor his followers examined real soils out of doors. They didn't need to! Once the simple idea of the balance sheet was accepted, the soil *had* to be a static storage bin of plant nutrients. The early geologists accepted this notion, too, and filled the storage bin with ground rock—sandstone, granite, glacial drift, or the like, resulting in "granite soil," "glacial soil," and so on. A few other features were recognized. Some soils were rich in clay—"heavy" soils to plow—and others rich in sand—"light" soils to plow. And, with the rise of biology, organic matter and microorganisms were added to the mixture but without fundamentally altering the concept.

It was inevitable, of course, that it should occur to someone to look at the soil, dig into it, and see whether it was really like it had been assumed to be in the balance-sheet theory. Credit for much of the early work on the soil itself belongs to the Russians. They found that soils in nature are made of a series of layers, or soil horizons, reaching from the surface to a depth of a foot or many feet. Collectively, these horizons are called the "profile" of the soil. In Europe and the United States, soil profiles are usually 2–5 feet deep. They are shallower toward the Arctic and deeper toward the equator.

Not only that, from just one kind of rock all sorts of soils, varying widely in color, chemical composition, productivity, and so on, were found. In fact, kinds of soil were

found to be more closely related to climate and vegetation than to the kind of rock. Whereas rocks are distributed more or less promiscuously over the earth, as far as the present environment is concerned, areas of individual kinds of soil occur in an orderly, discoverable, geographic pattern. Each distinct combination of climate, vegetation, parent rock, relief, and time—called the five genetic factors—gives a soil with a unique set of characteristics—a soil type.

This is a far cry from a simple storage bin. As the surface horizon of a sloping soil is gradually eroded away, the upper part of the horizon beneath is gradually changed and incorporated into its lower part. In turn, the upper part of the third horizon is changed and becomes the lower part of the second, until finally new, fresh minerals from the rock beneath are incorporated into the lower part of the lowest horizon. Other soils, instead of having fresh minerals added to the bottom, have them added to the top. Silty coverings are left by the overflow of rivers onto the surface of young alluvial soils like those along the Nile. (Probably a third of the people of the world get their food supply from alluvial soils.) On many soils dust and volcanic ejecta fall. As air enters and leaves the soil with wetting and drying, some gases are expelled and others absorbed. Rain brings soluble materials from the air, and percolating water leaches out materials. These actions change the soil materials because the various minerals and other compounds vary in solubility and rates of decomposition.

And so it goes. These and other physical and chemical processes are modified profoundly by plants, animals, and microorganisms. Nutrients are collected by the living matter, held against the forces of leaching, and returned gradually to the soil.

Thus, a soil is a solid, changing piece of landscape. Its upper surface is the surface of the land; its lower surface is defined by the lower limits of biological forces; and its sides are boundaries with other kinds of soil where there is a change in one or more of the five genetic factors. There are changes between day and night, from one rain to the next, from season to season, with plant successions, with shifting climate, and over periods of geological time—to say nothing of man's interference.

Thousands of distinct kinds of soil exist in the world. Each has its own set of characteristics, its own combination of environmental factors, its own dynamic, and its own potentialities for response to management. Some can furnish enough calcium, potassium, phosphorus, iron, or other mineral nutrients for crops indefinitely. Others respond greatly to one, or perhaps several, nutrients when first used. In some soils, nutrients become available to plants as fast as they are withdrawn; others are soon exhausted. Nor is the ability of a soil to furnish any nutrient measured by the total amount present.

This brief recital touches very lightly on just a few of the better-known processes. And yet some people, even scientifically trained people, can still be heard to say: "A soil is like a bank. One must put in what he takes out." What plants require for growth and what soils contain are relevant, but these values can help us significantly only where we know a great deal more about the soil. Because a soil in Maryland gives a good response to some fertilizer is no proof that one in Iowa ever will, regardless of how long it it cropped.

This balance-sheet theory does a lot of harm. Its superficial appearance of reasonableness delayed fundamental soil science for many years. It oversimplified the soil in terms of analytical chemistry to the neglect of the physical and biological characteristics and other qualities influencing soil productivity as much as fertility. It has delayed the recognition by farmers that different soils should have different fertilizers according to their nature. Even now, farmers generally are using mixed fertilizers, containing nitrogen, phosphorus, potassium, and perhaps other elements, as a sort of "shotgun" treatment on soils where only one or two of these nutrients are needed. Efficiency in the use of fertilizers demands that those nutrients be used that are needed to supplement the individual natural soil in order to make it a productive, arable soil for the plants to be grown. But a believer in the balance-sheet

theory, whether fertilizer technician or farmer, avoids a lot of thought and trouble. He doesn't need to look at the soil or study it. It's like a bank.*

The erosion menace. The followers of the balance-sheet doctrine practically ignored soil as landscape. Many early agriculturists, like Jefferson, for example, emphasized the characteristics of soil. He invented a plow—the "plow of least resistance"—and practiced contour tillage to prevent excessive washing, or erosion, on the slopes. From time to time, later agriculturists and geologists studied this problem of soil washing and directed attention to the great gullies already eating away at good soils in parts of the United States. For years, scientists in the American Soil Survey emphasized the problem in reports on many counties where it existed, hoping some action would be taken, but few people were interested.

Then, about 1926, a few popular articles on soil erosion attracted public attention. The success of these stimulated others. Soon many articles and books were appearing on the dramatic story of catastrophic erosion. Pictures of great gullies were printed along with statements of the cost of erosion to the United States. Estimates were made of the plant nutrients—phosphorus, potassium, calcium, and the like—washed as soil material into streams, lakes, and oceans. Assuming that all these are available to plants, assuming a value for the chemical nutrients equal to that of commerical fertilizer, assuming that all sediment is useless, and assuming that the material exposed by erosion is all sterile—cost figures become truly astronomical.

On top of a bad business depression came the severe drought of the thirties and inevitable soil blowing in many parts of the Great Plains. By many this was regarded as soil erosion too—wind erosion. So to the pictures of deep gullies and washed slopes were added those of the skulls of starved cattle on windswept plains and of abandoned homes, half concealed by drifted soil.

For a time, it almost seemed that each popular writer was trying to outdo the others in dramatic statement. Some even went so far as to assert that erosion had previously swallowed whole civilizations; and others, that the League of Nations caused the great erosion catastrophe; or that we should tear up our democratic institutions and do what was necessary at once to save ourselves; or that country people are too ignorant anyway to learn how to handle the soil!

A few even went a little further, but not much—there wasn't any further to go. But today's writers are more sober. The great production record of American farmers during the past war has had some steadying effect. But, more important, a very large number of people are now acquainted with the problem at firsthand. It is sincerely to be hoped that the period of extreme statement on soil erosion is nearly over, else it might stimulate some counteraction just as extreme. Excessive erosion—accelerated soil erosion—*is* a serious problem in parts of our own country and in many other places in the world. Like other soil problems, it has been long neglected and it demands attention. Unless farmers are careful, there will be bad soil blowing again during drought years in the Plains. Another period of very low farm prices will amost certainly be accompanied by serious soil erosion.

Not all spectacular erosion is caused by man's use of the land. Much of it is a perfectly normal concomitant of mountain building and wearing down. Nor is it all harmful; in fact, an important part is essential to the formation of productive soils. One cannot, or should not, try to stop erosion, but rather to control it. On the other hand, some of the erosion least conspicuous to the casual observer is most harmful.

The effect of a removal of the surface soil horizons by erosion varies with the soil type. An otherwise productive soil with a massive clay pan or hardpan at 18 inches may be severely damaged by the removal of 6–12 inches of surface soil, whereas one with a deep friable profile may not be influenced at all, provided the process is stopped short of

* The confusion is heightened by an old fertilizer trade slogan, "Feed the plant not the soil," along with substitution of the incorrect term "plant food" for both plant nutrients and for that portion of a commercial fertilizer that consists of plant nutrients. Of course, the food of plants consists of organic materials synthesized by green plants from the nutrients taken from the air, water, and soil.

gullying. In fact, the more serious erosion injuries to soil are not chemical, not the loss of plant nutrients, but the change in structure, the loss of crumblike surface horizons and the exposure of massive clays, hardpans, or even solid rock.

Why do arable soils erode or blow? Generally, it may be said that a thick-growing vegetation has been replaced by a weaker vegetation or by widely spaced plants, thus exposing the soil to the forces of rain, running water, and wind. This can be brought about by drought, fire, cutting, close grazing, excessive cropping, and tillage. On any one soil type, the hazard of erosion depends upon the sharpness of the rains, the force of the winds, the permeability of the soil and its capacity to take in water, its slope, and its productivity for plants. Under clean cultivation, some soils with only very gentle slopes erode badly. At the other extreme, some steep soils are so pervious and productive that they may be cultivated safely. On highly fertile soils, a protective cover grows quickly. And so we might go on. Thus, specific answers to questions of erosion hazard or effects must be worked out for the alternative management practices on specific sets of soil characteristics, or soil types; and in detail, since these practices are parts of the management plan of very small units—fields and farms.

How can erosion be controlled? Although one should not push the analogy too far, this is like asking: How can a headache be stopped? That is, a headache is usually a symptom of some deeper maladjustment. So it is with harmful erosion: one must get at the cause and correct it. Concentration on mechanical devices alone to control the actual erosion itself may be fruitless—even injurious to the soil—if some fundamental causal factor like phosphate deficiency is neglected. Back of the phosphate deficiency we may find any one of a dozen reasons.

Generally, when a rural population becomes poverty-stricken, it fails to maintain its soil. An exploited people pass on their suffering to the land. Low prices, disease, and wars are all important causes. Things get on a hand-to-mouth or year-to-year basis. It is hard to look ahead of the immediate income. Where farmers can take a long view of production over a period of ten years or more, there are very few instances of conflict between those practices that give most return and those that maintain the soil from loss of fertility, erosion, destruction of soil structure, or other deterioration—and not only maintain it: a large part of the arable soils of the world are made better by good farming than they were naturally.

Then, too, when people move to a new area, onto a new kind of soil, the old practices and traditions may persist too long. The new soil may deteriorate before they have learned, through trial and error, how to manage it. Fortunately, modern science can shorten such periods or even eliminate them.

Thus, soil-erosion control is not an isolated problem. It is one important aspect of soil management for secure production in many places. Control must be sought within the whole management system of the land. It would be unfortunate for soil erosion to be neglected as it was in former years. It would be unfortunate for it to be exaggerated or overemphasized at the expense of other problems of soil use. Above all, concentration on the erosion itself to the neglect of its causes could be wasteful or even harmful. Many of these causes go back to economic and institutional maladjustments between soil and people. Fortunately, the trend is now strongly in the direction of a more balanced soil-management program in our own country, and in many others as well.

Although soil scientists may continue to regret the extreme statements about erosion, they should admit that the dramatic stories about it did much to make the public more conscious of soil problems than ever before.

The organic schools. For years most practitioners in the fertilizer field accepted the balance-sheet theory. Only recently have many of them sought an understanding of soil types. We have already seen how that doctrine viewed the relationships between plant roots and soils largely in terms of analytical chemistry. Even soil scientists themselves have given soil biology a relatively small place, except for the microorganisms concerned with nitrogen fixation.

Partly as a reaction against the simple

balance sheet, biological theories of soil productivity have arisen that lay all emphasis on living plants, soil organisms, and organic matter. Greater recognition of biological factors in soil management has been long overdue. But the advocates of the organic-matter doctrine go very far. They insist that organic matter is everything, or nearly so; that the usual chemical fertilizers are downright poisonous to soils; that the liberal use of compost gives special qualities to plants—they will be free of insects and diseases; and that animals, or even people, will be ever so much more healthy by eating plants grown "the organic way."

Within the organic group are separate schools. Some derived their notions from Goethe, by way of Rudolph Steiner; others from experience with compost in tropical countries. Important as these differences may be to the devotees themselves, they need not concern us now. Many of the recommended practices are excellent, although not always for the reasons given.

Organic matter in soil is a very general term. It includes the living forms—roots, fungi, bacteria, and small animals; fresh remains of living matter; a more or less stable decomposition product, brown or black, called "humus"; and a host of intermediate products. The final decomposition products are, of course, water, ash, carbon dioxide, and a small amount of other gases. Perhaps the great importance of organic matter may best be realized by listing its functions in soils. The relative significance of the several items varies a great deal among different soil types. In no soil are all important at once.

1. Organic matter promotes granular structure and pore space in some soils. Thus, it may—
   a) aid root extension;
   b) promote entry of water into the soil;
   c) reduce soil washing;
   d) reduce soil blowing;
   e) promote aeration or exchange of gases;
   f) increase the water-holding capacity; and
   g) reduce baking and crust formation.
2. It reduces the extremes of temperatures, especially high summer temperatures, when used as mulch.
3. It reduces evaporation, especially when used in the surface or as a mulch.
4. Humus aids in the maintenance of reaction (pH) in the soil by acting as a buffer.
5. Organic matter aids in the retention of soluble substances, including many plant nutrients, by holding them in living or nearly fresh forms against the forces of leaching and by the base-exchange properties of the humus.
6. Part of the organic matter furnishes a food supply for microorganisms and small animals in the soil, including forms essential for the transformation of nitrogen compounds and for other processes important in plant nutrition.
7. Organic matter furnishes directly, and indirectly by promoting bacteria and fungi, complex organic compounds which may include both growth-promoting and antibiotic substances. Very little indeed is actually known about the role of these compounds in soil productivity.
8. Additions of organic matter, especially from normal plants of mixed types, maintain a slowly available, fairly well-balanced supply of plant nutrients, including the micronutrients. This is very important everywhere, but especially so in warm humid countries where leaching is severe and fertilizers expensive.

Where organic matter is used to control temperature and evaporation, relatively fresh material is used as a mulch. When used wholly or partly as a source of nutrients, the material is often partly decomposed in advance. Such partially rotted material, or leaf mold, may be found naturally just above the mineral soil and under the surface layer of dry leaves in the forest. Commonly, it is made as compost.

The devotees of the organic schools have made rituals out of compost making. Fine points are argued about as heatedly (and with about as much reason) as recipes for mint juleps or Virginia ham. Some add special "secret" concoctions, to encourage certain microorganisms, it is said. These "secrets" are passed on only to the most trusted of the faithful. Most insist that at least a part of the mixture must be animal products. Although soil scientists generally advocate adding chemicals to the mixture, nearly all true believers condemn their use. The unforgivable sin is to add any "chemical" nitrogen, such as ammonium sulphate or ammonium nitrate, to soil or compost. Rock phosphate may be used; but superphosphate is condemned, because it is made by treating a natural earth with sulphuric acid—a strong poison. (Even that should not be so bad as common table salt—a resultant from two strong poisons!)

At great risk, we may state that the essential

features in making compost consist of piling things like leaves, grass clippings, straw, and other plant remains in heaps some 4–6 feet wide, 6–12 feet long, and 4–6 feet high, let us say. Very thin layers of soil separate layers some 6–8 inches thick of organic matter. The material is kept moist, but not soggy, and allowed to decompose. If turned occasionally, it will be improved in both chemical and physical properties. If nitrogen is added as animal manure or fertilizer, the yields of good compost will be higher. Some ground limestone and superphosphate or rock phosphate are added. Many use a little mixed fertilizer.

The principal point in the process is the reduction of the ratio of carbon to nitrogen. In normal soil, this ratio is in the neighborhood of 10 or 12. In the fresh organic matter, it is much higher—30 or 40, or even more. If the fresh material is added to the soil directly, microorganisms will increase enormously in the soil, using the energy-giving carbohydrates. They require nitrogen for their bodies and will compete with plants for the available supply. Of course, when the carbohydrates are used up, the numbers of microorganisms will again return to normal and the nitrogen in their bodies will be available to plants. But by composting in advance, this initial period takes place outside the soil, and the resulting compost contains nitrogen available to plants. Further, decomposition in the soil of fresh organic matter requires more moisture than is sometimes available. The compost is in much better physical condition to use than fresh organic matter.

The ratio of nitrogen and carbohydrate, on one hand, and phosphorus, on the other, must be watched also. If both nitrogen and carbohydrate—energy material—are high, microorganisms will greatly increase and use a lot of phosphorus in their bodies. If the available supplies in the soil are low, plants will suffer phosphate deficiency. Thus, partially composted organic matter, rich in nitrogen, may give bad results unless the compost is enriched with phosphatic fertilizers or generous amounts are supplied to the soil.

Of course, the nitrogen in a chemical fertilizer is not different than the nitrogen in compost. But the organic schools have an important point, often missed because of their extreme statements: If chemical nitrogen is used as a *substitute* for maintaining a reasonable level of organic matter and for growing legumes, the soil may deteriorate badly through loss of structure, and the erosion hazard may be increased. Then, too, it is entirely possible to use too much nitrogen fertilizer and have an excess of soluble nitrogen in relation to the other plant nutrients. People often do so in their gardens, getting as a result tall, weak, poor-fruiting plants. Many things good for people or for soil, in moderation, are harmful in excess. Yet, if on a well-managed productive soil, one may raise the yield of corn from 30 bushels per acre to 75 bushels, let us say, with a commercial nitrogen fertilizer, it would be unwise not to do it.

The organic partisans exaggerate nearly as much as the erosion enthusiasts. All sorts of claims are made for disease resistance among plants treated with compost (made according to the particular author's ritual). Plants need all the elements the scientists say they do, some admit, but go on to insist that they need also a mysterious life-giving substance, a vital principle produced only by other living matter. Much that is written is pure speculation. Although, like Berkeley's theories, one cannot prove them wrong, there is no reason to believe them.

Such exaggeration and speculations are unfortunate. A great deal that is advocated by the organic schools is sound practice, even if they do often give unbelievable reasons. Certainly their implied concept of the soil is as good as, if not better than, that of their arch-enemies, the balance-sheet advocates.

Since much work is involved, these organic theories appeal most to small, hobby gardeners, especially those working with poor soil. And under such conditions, results will very likely be much better with the organic methods than with those of the balance-sheet school. But such a choice is not necessary. Both involve some good practices and some unnecessary ones. And both fail to emphasize the selection of plants best able to grow on the soil at hand. In ordinary large-

scale farming, animal manure or nitrogen fertilizers may be applied along with organic matter to offset the effects of high carbohydrate content and avoid the need for composting. In the United States composting would need to show a great benefit indeed to make the method economically practicable. Considerable success is claimed in the humid tropics with "organic farming" where labor is plentiful, where organic matter is especially important, and where fertilizers are very expensive or difficult to obtain.

The organic devotees are primarily interested in production. They have not teamed up much with the erosion enthusiasts except to use their astronomical figures of damage to "demonstrate" the evils of chemical fertilizers and of failures to farm the "organic way." They also use the statistics on human disease to show the same thing.

As with the erosion problem, perhaps it takes exaggeration to bring recognition of the biological side of soil productivity, and such recognition is important. Here, too, there seems to be somewhat more reasonableness coming into the current popular articles, especially in the United States.

Earthworms. Enthusiasm for earthworms, among the many soil organisms, can scarcely be accounted for on scientific grounds. Perhaps it is because they are slow in their movements and large enough to be seen easily. Somehow they do seem more friendly than their quicker, many-legged associates. Most people who like the soil at all like earthworms.

For plants to get the nutrients in organic matter, it must be decomposed. Humus is the result of partial decomposition. The role of decomposer is played by a whole host of soil organisms. The large ones also mix the organic matter with the upper mineral soil, dragging bits of it down into holes in the ground. The friendly earthworm is only one among the many.

Years ago Charles Darwin wrote a whole book about earthworms and their influence in forming "vegetable mold" in the surface of the soil. It is perhaps still the best book. He measured some worms and their casts and showed that over a long period their effects were considerable. Farm and village boys digging earthworms for fish bait, look for them in fertile garden soil. But not all productive soils have earthworms, and they are sometimes found in soils of rather low productivity; still one is more likely to find them in productive soil. Even now there is no definite answer to the question: Are the earthworms present because the soil is productive, or do the earthworms make the soil productive? Probably it is some of both.

Recently, great claims have been made for soil improvement by earthworms, usually as a special phase of "organic" gardening, since they need organic matter as food. Here again the soil scientist must say that he does not know. Possibly earthworms do have some special advantages over other organisms; possibly they may be harmful where soil organic matter decomposes too fast anyway. The scientist cannot say it is bad practice to destroy them or good practice to introduce them. Yet even the scientist probably likes them in his garden—most people do.

Plowless farming. More than two hundred years ago Jethro Tull invented a grain drill and a horse hoe. Grains were planted in rows and cultivated, and yields were increased greatly over the older broadcast sowing. Tull taught that this benefit came from the very pulverizing of the soil, making it easier for the fine earth to enter the roots. This view has been long rejected. The great benefit from Tull's system came largely from the better control of weeds, which had become very bad in English grainfields.

A tradition arose, however, among European and American farmers that it was beneficial to plow and to cultivate a great deal. The invention of the steel moldboard, or turning, plow has been regarded as a great milestone in soil management, coming as it did during the breaking of the American prairies. It made plowing easier and neater. As cultivation spread west on the dry soils of the Great Plains, it was emphasized as a technique for saving water. Under the "dry-farming" system advocated at the end of the nineteenth century, crops were alternated with cultivated fallow. During the fallow

year, moisture accumulated and a crop could be grown the following year. By maintaining a very loose surface soil—a "dust mulch," it was called—capillary rise of water to the surface was thought to be broken and the upward movement of water halted. But more recently it has been shown that here again the principal benefits came from killing weeds which robbed the soil of moisture. The farmers who went into the plains took their tools and methods with them, including the turning plow. They had to learn other methods.

For a long time soil scientists have been arguing against too much tillage. Obviously, unnecessary tillage wastes power. But, even more, tillage tends to destroy soil granules, to injure soil structure. The effects are, however, more striking in some soils than in others.

A few years ago came a new theory, full-blown overnight: Stop plowing altogether! It was supported by all sorts of carefully selected evidence. For one thing, how about the great dust storms of the early thirties? Had not the popular books on erosion shown that the moldboard plow was the evil instrument that had destroyed the grassland? Was it not the moldboard plow that tore up the slopes in the humid region now suffering from sheet wash and gullying? Is not the forest productive without plowing? Assertions went almost to the point of implying that all soils in America were originally productive, but that they vary from one another now because some have been plowed more than others.

Seeds can be planted and plants may be grown without plowing, or even with very little tillage of any sort. If plant remains are left on the surface, not plowed under, the soil will be protected against the forces of rain and wind. According to the advocates of plowless farming, soil organisms thrive better, plants are healthier, yields are much higher, and, of course, costs are lower. In fact, as plowless farming becomes general, the really big problem will be what to do with all the great increase in farm products!

So the question arose: Why plow? Look at the bounty of nature! And does she plow? Let each farmer answer for himself: Exactly why plow?

Now, this was a good question. A lot of people, agricultural experts as well as farmers, did not have a ready answer. Most farmers had plowed because it was more or less traditional to do so. For centuries, many farmers had plowed. Most of the standard books on soil science explained how to plow and when to plow, but few explained why one should plow at all.

The truth is, however, that already many tillage machines were in use instead of the turning plow in the Great Plains—machines like the one-way disc and the duckfoot cultivator. Many bulletins had already been issued to farmers explaining the use and advantages of such machines over the turning plow. Curiously, these were ignored for a time by both advocates of plowless farming and most writers of books on soils.

In the face of such claims, and with few clear reasons against them, some farmers and gardeners in the eastern part of the United States—especially city gardeners—put the theory to test. On the whole, results have been disappointing. Some took the doctrine literally and planted corn in fields of Bermuda grass—corn that got a few inches high, turned yellow, and finally perished.

Of course, plowless farming worked successfully on a good many kinds of soil, as alert farmers had already discovered. In fact, machines were already available for carrying on the necessary tillage for controlling weeds and preparing seedbeds that would leave trash and clods on the surface to protect soils from washing and blowing. But these were different soils than those traditionally plowed in the humid regions.

The kind of tillage required depends upon the crops to be grown and especially on the kind of soil. Most soils in humid forested regions are not naturally productive for crop plants. Among the very poorest are nearly level, deep, stone-free soils with clay pans or hardpans. The term "worn-out soils of the East" often refers to these. But they aren't worn out; they never were productive. On the other hand, the black soils developed under grasses in the subhumid region are

naturally productive for similar plants—crop plants.

So, in humid forested regions like Eastern United States and Western Europe, most soils highly productive for crop plants must be made so by the farmer from relatively unproductive natural soils. Soil fertility must be increased. Soil structure must be improved, made granular, to a considerable depth. This means microorganisms and roots need to be encouraged. They require organic matter, lime, and fertilizers, not only in the surface horizons but also in the deeper ones. Therefore, one plows as the best way to accomplish this purpose.

There are other reasons. On many soil types, systems of tillage involving the use of the turning plow are best to control weeds, to prepare a seedbed, and to make the soil receptive to rain water. On other soils such deep turning is not necessary, or even proper, and systems that avoid the turning plow are better.

Aside from the disappointments and a few financial losses from trying plowless farming on soils where plowing is essential, the net effect of the doctrine has probably been good, absurd as its claims and reasons turned out to be. It jarred lots of people who had just taken plowing for granted into considering tillage critically. Was plowing necessary? Tests were made, and the results of older tests and experience re-examined. The inevitable result has been that plowing is found to be necessary on many soils and not on others. Farmers generally—of course not all—*had* plowed and cultivated too much.

As a result of the controversies that the doctrine stimulated, at least a few more people have thought about soil and now realize a little better why they do what they do.

Apparently the extreme doctrine will disappear almost as quickly as it arose, but more quietly.

"Balanced" minerals. Scientists in plant nutrition have been fairly well agreed for some time that at least fourteen elements are essential for plant growth. These include carbon, hydrogen, and oxygen from the air and water; and phosphorus, potassium, nitrogen, calcium, magnesium, sulphur, iron, boron, manganese, copper, and zinc from the soil. Certain soil organisms can use nitrogen from the air. Somewhat more recently molybdenum has been added to the list, especially for clovers. Only small quantities of molybdenum, iron, boron, manganese, copper, and zinc—often called the micronutrients—are needed, although the actual amounts required vary widely among plants. Common salt (sodium chloride) also stimulates the growth of certain crops on some soils when used as a fertilizer. In addition, iodine and cobalt are known to be essential for all or certain animals, and they obtain these largely from the food they eat.

Besides these, a great many other elements—in fact, most of them—may be found in plants. Some kinds of plants are especially rich in aluminum, gold, silicon, or other elements where certain compounds of the element are present in the soil in considerable quantity. Since these and many other elements are often present, one wonders how they influence the plant, if at all.

Fertilizer practitioners have given greatest emphasis to the "big three" plant nutrients—phosphorus, nitrogen, and potassium. Calcium has been thought to be abundant in nonacid soils and usually taken care of by liming in acid soils. In recent years, however, increasing attention has been given to magnesium, sulphur, and the micronutrients. In many instances, applications of one or more of these have been very beneficial.

Neither plant nor animal nutritionists can explain entirely the roles of the micronutrients that are known to be essential, let alone any possible effects of the large number of other elements (except for some of the established poisons) taken in by plants and animals. Nor are the optimum environmental conditions, including nutritional balances, known for the synthesis of vitamins and other growth-promoting substances.

Could it be that some of these micronutrients, even those having no clearly established functions, are in some way responsible for the synthesis in plants of certain organic constituents of nutritional significance to animals and humans? Even though the scien-

tist would hesitate to say yes, he cannot say no. He doesn't know.

What a field for speculation! Here may be the key to better health and nutrition, even to the long-sought elixir to give us perpetual youth. It is only a step from the scientist's statement that he doesn't know whether these elements have important undiscovered effects to someone's saying: "Perhaps they have"; and finally to the idea "They *do* have."

Some have taken this final step. The claims vary from emphasis upon the micronutrients known to have at least some definite influence on growth to an impressive list of these and many more. The evidence offered includes good production, but not significantly greater than under good nonmysterious management; the fact that plants growing naturally contain such elements; and the improved nutritional value of the plants for man and beast. This last is easier said than proved. In fact, with the very best scientific facilities, it is exceedingly difficult to make accurate comparisons of foods through feeding trials to test such plants.

Research is badly needed in this area. Not, of course, to prove or disprove the claims of extremists for balanced minerals, but to uncover the facts, to find some basic principles of prediction value. There is great danger that before the facts are found much money and effort will be wasted on special fertilizers of "complete minerals." It is known that alfalfa, sugar beets, and other crops are especially sensitive to boron deficiency; tung trees are especially sensitive to zinc, as is the pecan; and so we might go on through a very long and complicated list. But there is another list of plants according to toxicity hazards to many of the same elements; that is, on the same soil, the same amount of boron may increase the yield of one crop and lower that of another.

As important as these plant preferences are two other factors: the available amounts in the soil throughout the root zone; and the general soil-management system—green manures grown, other fertilizers applied, liming practices, manures and compost used, crop rotations, and irrigation practices.

Soil scientists are going ahead slowly. Already methods of diagnosis have been fairly well developed for some crops on some soils. But these are time-consuming and highly technical. Not with even one of the micronutrients are there methods that will work generally.

Additions of reasonably small amounts of these special mineral fertilizers will probably not do much harm, except when a soil already contains a large amount of one of the elements in available form; in some instances, the applications may do some good. But the chances of meeting the actual soil needs are remote. There is no such thing as a generally "balanced fertilizer" in the sense usually implied—balanced for plants growing in soil—for all soils or even for the soils of a considerable area. As soon as a chemical mixture is added to the soil, reactions take place within the soil. The final "balance" of nutrients is quite unlike that added in the mixture. The aim in scientific or balanced fertilization is to add what is essential to achieve a balanced nutrient supply for the plant within the soil. This often requires two entirely different fertilizers, or fertilizer mixtures, for the same kind of plants growing in adjacent fields or gardens on different soil types.

Soil and health. Careful comparisons between soil geography and human geography show many extremely interesting and important relationships. Describing such relationships is one thing, and proving causal mechanisms quite another. In the past twenty-five years or so, several important relationships between soil conditions and nutritional diseases of animals have been fairly well established. These researches have been expanding generally throughout the world.

Questions then naturally arose as to what extent human nutrition and health might be related directly to types of soil and soil-management practices. Several soil scientists and nutritionists alike realized the possibility of important causal relationships. The problem is almost unbelievably complicated by the great number of combinations of relevant factors and the technical difficulties of the research. For dependable results, the study of

relationships must begin with the soil type, considering its total environment and cultural treatment, and the plants grown. Then account must be taken of how the plants are processed into food, food storage, combinations of foods used, and so on. Finally, the study must be carried into the medical clinic.

A little evidence is in—about enough to show that some highly important relationships exist but that it is very difficult to obtain principles of real prediction value.

Unfortunately, some practitioners have taken the "long jump" from these conclusions of the scientists to claims of knowledge now. Of course, assertions that certain soil types or certain cultural practices give food of special health-promoting value stimulate the emotional interest of readers. Everyone wants to avoid sickness and be strong.

Such claims are made by some extremists of the "organic-farming" schools. Some advocates of the balanced-minerals fertilizers also promise healthful, even disease-curing, food plants. It has been said definitely that erosion lowers the nutritional quality of food plants. Extravagant claims have also been made for ordinary liming and fertilizing.

Any of these *may, under certain conditions,* be true. Certainly, none is generally true under most conditions. Several significant local problems of great importance to the nutrition of livestock have been worked out. But there are very few proved relationships with humans developed to a point where definite predictions can be made.

But before that happy day comes when the relationships between soil and food quality are well enough known that food can be graded according to quality, based upon soil type and cultural practice, the public will doubtless be presented with many more claims. In other words, dogmatic assertions on soil and health seem to be increasing rather than diminishing. Soil scientists and their colleagues in plant and animal nutrition and medicine have already made a reasonable start on this very complicated research. The great danger to their research right now is public reaction against the claims of the extremists—claims that the scientists find hard to deal with because they do not yet know the facts.

THE COMMON DIFFICULTIES

None of the various doctrines about soils can be declared to be wholly true or wholly false. Very few, if any, soil scientists are clearly identified with any of them. Although the doctrines differ from one another —some pairs very widely indeed—they all have three difficulties in common.

In the first place, their advocates hold a firm conviction—originally from revelation or authority, it doesn't matter—based upon something besides the complete soil. In the balance-sheet theory, for example, it was a notion of plant nutrition. In others, it was some superficial appearance of the land, or even of the very upper part of the soil—the part plowed or turned in spading. After the theory was firmly believed, *then* a concept of soil was developed to accommodate such a theory. In soil science, on the other hand, one begins with the facts about the soil itself, as well as these can be learned with the scientific tools at hand.

Second, all the doctrines imply that soil is everywhere about the same, except as modified by man's use. Because a practice seems to work well in one garden or one field, the extremist generalizes widely. Some have talked about "average depth of fertile topsoil," for example, in the United States or in the world. Naturally, unproductive soils are sometimes called "worn-out" soils. Actually, there are thousands of unique soils in the world, varying from one another in every respect. Some have little or no "dark-colored fertile topsoil" and never did have; others are black to more than 3 feet. Some are highly erosive even with gentle slopes, whereas others are not, even with steep slopes. Many steep, thin, stony soils always were steep, thin, and stony. And so it is with all characteristics of significance to soil productivity and use. "Soil" is a very broad term, like "plant" or "animal."

Third, these doctrines, especially in their most extreme aspects, deal with areas of the subject about which science knows the least.

They nearly always seem to affirm most strongly what scientists cannot deny for lack of evidence.

A GLIMPSE AHEAD

All this should not be taken to mean that soil scientists have no disputes among themselves. Of course they have, as in any science where advances are being made. But such disputes are in different terms than those among the advocates of the doctrines. They deal with facts and their interpretation according to the scientific method.

Nor should it be inferred that soil science is a helpless baby—not at all. It is young and still cannot answer many important questions. But it can and does answer fairly well a great many questions about a great many kinds of soil. Until recently, farmers, gardeners, foresters, and engineers learned about the soil through trial and error, with all its costly failures and headaches. Now, every day, in many parts of the world, soil scientists are making reasonably good predictions about the behavior of soils with many kinds of practices. In the future, they will know how to make these more accurately, for a longer period, and on all important soils. They will develop many new practices and understand many more relationships between soil and use. This goal can only be approached the hard way—through painstaking fundamental research. Then comes the applied research and demonstration.

If these doctrines have helped to make the public conscious of the importance of soil and the need for fundamental research, they, too, will have helped to lay a basis for substituting scientific prediction for habit and trial and error, even if indirectly.

FOR WE ARE ONE

Home is the earth, and all that here abounds,
A princely gift from Time's unending past,

A universe to thrill our opening eyes,
A sun for strength, and with companion earth
To bear us up, and give to all full life,
To bird and beast and every growing thing,
To man, as kin to these and one another.

E'en though our thoughts do reach beyond the clouds
How deeply rooted are we in the soil
That feeds and gives us heritage of power:
Our liquid gold, black diamonds, metal slaves—
As with clay and mind we build a pleasant home.

Yes, all the earth is home, and there is much
To make us one, as one we are, indeed.

THOMAS P. MONAHAN

MOSES IN THE LABORATORY

STELLA B. CAMERON

Born and raised in Oxford, England, Mrs. Cameron studied geography at Edinburgh University. She went to Canada in 1932 when her husband joined the staff of the Institute of Parasitology at McGill. She has always been interested in breeding exotic animals and introduced the golden hamster into Canada in 1938.

IT SEEMS so long ago that rabbits, guinea pigs, mice, rats, and monkeys were first introduced into the laboratory as experimental animals that it would be difficult to say exactly who introduced them and for what scientific purpose they were first used. This is not the case, however, with the most recent addition to the laboratory—*Xenopus laevis,* or Clawed Toad Frog. This article deals with our attempts to have it established on a permanent basis.

Macdonald College, located at Ste Anne de Bellevue, is a residential college of McGill University, Montreal, in the Province of Quebec, and, like so many similar institutions in North America, it was requisitioned during the war by the military authorities to house troops. In this case, the troops were women, and not all the College facilities were utilized by them. Among other things, some of the research activities of the College were continued, although their aim was directed toward war rather than peace.

One day, my husband (who is in charge of the McGill Institute of Parasitology at Macdonald College) received a telephone call from Ottawa. The Deputy Director of Medical Services wanted to know if he had a basement with running water in his Institute and, if so, would he be willing to permit the Army to use it as a pregnancy-diagnosis station. Since many members of the Canadian Army Women's Corps were married, and since the station at Macdonald College at that time housed a great many of these women, it seemed quite a reasonable request; so my husband said "Yes," but he was a little puzzled as to the need for running water. That was necessary for the South African frogs, he was told. A staff would be provided (which was fortunate as many members of his own staff were in the services), and the frogs would be flown over from South Africa in a week or so.

In a few weeks a telephone message came from the Montreal Airport at Dorval (then the headquarters of Ferry Command, Royal Air Force) to say that several cans containing about 300 live frogs had just arrived from Durban, Union of South Africa, and would my husband please do something about them —and quick! He did, and in forty minutes the cans of frogs were in the basement of the Institute. They had had a long flight from Durban—through Khartoum, Cairo, Gibralter, and London to Montreal—and had stood the journey remarkably well, although in later shipments there was a high death rate.

Fortunately, in the interval between the two telephone calls, we had had time to acquire some information regarding these frogs. Several peculiar and unexpected coincidences came to light. Before coming to Canada sixteen years ago we had been living in Edinburgh, where my husband was working in the Department of Zoology at the University. This department was housed next door to the Animal Breeding Research Institute directed by Professor F. A. E. Crew, who had established a pregnancy-diagnosis station for civilian use. He was using small mammals for the test at that time, but, just as we were leaving, he introduced the South African frog for this purpose. He called the test the "Hogben Test," after Professor Hogben, who had shown its theoretical possibilities in this direction. Hogben's earlier work was carried out at McGill, and he had actually lived in Ste Anne de Bellevue. In spite of these coincidences, neither my husband nor I had ever seen a South African frog, and it was necessary to hunt through quite a lot of literature before we really got to know them.

Xenopus laevis is a peculiar creature.

Although it is an amphibian and looks like a frog, it is not a true frog and is only distantly related to the frogs as we know them in North America. It has a broad, triangular head, very weak forelegs, and powerful hind swimming ones, with clawed feet. Its color is a dark brown with blackish markings, but it has the chameleonlike ability to change color—from light mustard in clean, warm water or if it is in a tank with a clear glass bottom, to almost black if in a tank with a dark bottom. It has no tongue and no teeth, but only ridges in its upper jaw. It is aquatic, but must breathe air. It is carnivorous and feeds by pushing small aquatic animals, including its own tadpoles and spawn, into its mouth with its front legs; it uses very little discrimination in feeding and will sometimes choke to death because of the large pieces of meat it tries to swallow. It is a very quick and strong swimmer, but prefers to rest in shallow water, with its hind legs on the ground, and its nose just above water level. It will stay thus for hours if left undisturbed, but will disappear quickly under the water if there is a sudden movement near by. Its favorite habitat, accordingly, is water about three to four inches deep. In nature it lays eggs that are fertilized, after leaving the body of the female, by the male, who clasps the female around the waist while so doing. Normally, it will not lay eggs in captivity, although in its natural habitat—which is Africa south of the Sahara—it pairs once a year in the spring and is very prolific with its spawn.

Specimens of this animal had been sent to the London Zoological Gardens as long ago as 1890, and, ten years later, Bles, working in the Zoological Department at the University of Glasgow in Scotland, had succeeded in breeding them. He did this by lowering, for some months, the temperature of the aquaria in which he kept them, then raising it again to about 70° F., in an effort to imitate the seasonable change from winter to spring. To simulate spring rains, some water was drawn from the tank, cooled, and sprayed back through a fine nozzle. Using this technique, he was successful in getting some of his frogs to pair and to lay fertile eggs.

The development of these eggs is as remarkable as the frogs themselves. They hatch in about thirty-six hours, and a little fishlike tadpole emerges and attaches itself by a fine filament to stones and weeds; or it may even hang from the surface of the water. It is white and about a quarter of an inch long. It remains thus for a few days, feeding meantime on yolk carried over from the egg. In three or four days it gradually darkens, becomes a typical *Xenopus* tadpole, and begins to feed on plankton. It is now almost transparent except for its entrails and the dark tail, which moves continuously as it balances itself in the water, head down, at an angle of about 45°, feeding as it does so on unicellular plants.

I was soon to become acquainted personally with these odd creatures, owing to the fact that quite by accident two male frogs had been included in the shipment from South Africa. In the next two years or so, a number of other shipments were received here, but all the frogs were females. Only the female is of value for the pregnancy test since the test results in the deposition of eggs by the *unmated* female after the injection of the pregnancy hormone.

Accordingly, the two unwanted males were quite definitely surplus, and my husband handed them over to me with the suggestion that I might see what I could do about repeating Bles' work. There proved to be no need to follow his technique, however, because Shapiro, of South Africa, in 1939 also succeeded in breeding *Xenopus* in the laboratory by injecting the same hormone into the male as was used to induce the female to lay eggs. This stimulated the male to pair with the female and to fertilize the eggs. There was no question of the simplicity of this technique as compared with that of Bles, and it was the obvious one to try first.

At the beginning of 1943, I injected the first male and female. These were placed in a small aquarium with plankton, sand, and various water weeds; the day after the male and female had paired, hundreds of eggs were laid, and the two frogs were removed from the tank. Each day I watched for any sign of life, but it was not until the fifth day, when

all hope had been given up, that one tadpole was seen swimming about. This tadpole was promptly named "Moses"—and Moses it is still named.

The very fact that one had survived was enough encouragement to continue, but, with only two males, breeding was, of necessity, slow. After oviposition, both males and females must be given approximately four weeks' rest. The second pairing with the other male was more successful, inasmuch as ten tadpoles survived.

In about six weeks, Moses' front legs appeared, the transparent fan-shaped head began to disappear, and the typical *Xenopus* head was forming. At this time, the first male was injected again, together with another female. From that pairing we had about a hundred live tadpoles.

Moses had now developed into a frog, except for a short tadpole tail. He was removed to a tank with about one inch of water and, as he was now carnivorous, was fed on small pieces of minced beef heart, held in front of him on the end of an applicator. The other tadpoles were also growing at a very encouraging rate.

With only the two males, it seemed an endless time before they could be injected again. I gave up the water weeds and put large stones in the aquarium. This worked very well, and we were rewarded with hundreds of tadpoles adhering to the stones and hanging from the surface of the water after our next pair was injected. Moses now had several companions in his tank, but he remained the largest, owing, no doubt, to the fact that he had received individual attention when young.

After dividing the enormous number of tadpoles we now had into batches of 100 to an aquarium, the two males were given a long rest because of lack of space for further tadpoles.

Moses by this time had developed into a female!

When Moses reached the adult stage, she was injected along with a male a few weeks younger than she. It was with some trepidation that we watched to see whether the second generation would react to the hormone. All doubt was dispelled when we found the stones at the bottom of the aquarium covered with eggs the next day. Two weeks later, from this tank 2,633 tadpoles were separated into various tanks.

One presumes that in nature the sexes of *Xenopus* are fairly evenly divided, but I have had many more females than males. Perhaps this is due to the fact that the female is always larger than the male when adult, and often at the metamorphosing stage, when the death rate is very high, the tiny frogs—about as large as a house fly, before the tail has entirely gone—will be found dead in the tank; these may be males.

It is a comparatively simple matter to induce the frogs to pair and have fertile ova, but it is quite a trick to get them past the critical metamorphosing stage. However, although even with the greatest care one loses thousands, hundreds live, and once they have developed into frogs, the death rate becomes very, very low.

Landgrebe, of Aberdeen, Scotland, reported having kept one of these frogs for fourteen years. As it takes them about two years to reach the full adult stage, it is encouraging to know that they may live so long. They can be used for the pregnancy test a little younger than two years; moreover, with suitable treatment and feeding they can be used repeatedly. The feeding and maintenance of the adults themselves is simple and inexpensive.

The only drawback to the utilization of this useful laboratory animal was the problem of having to import them from South Africa. The time has passed when this was necessary, and I have now reached the stage where space is the chief factor in continual breeding—even 2,000 frogs take up a fair amount of room!

CONTACT LENSES

IRA LUNAN FERGUSON

Professor Ferguson took his M.S. in preventive medicine and public health at Minnesota in 1941. During the war, he was in Washington with the Office of the Surgeon General as associate consultant in the Production Control Division, and later as statistician in the Medical Statistics Division. He is now associate professor of health education at Southern University.

FOR years, scientists have sought to produce eyeglasses that would be as inconspicuous as possible. Today, defective vision can be corrected with lenses that are practically invisible. These modern miracles have no frames, nose bridge, nor earpieces to annoy. It is estimated that there are now approximately 35,000 pairs of contact lenses being worn in the United States, and their popularity is steadily increasing.

Contact lenses are thin, oval-shaped lenses about the size of a 5-cent piece. Formerly made of glass, they are now made of smooth, nonirritating plastic which may be ground to any power for the correction of eye defects. They are worn under the lids, immediately over the eyeball. The principal purpose of the contact lens is to support, in apposition with the cornea, a fluid. The cornea, that clear, transparent, glasslike but hard protective surface in front of the lens of the eye, has a greater curvature than the rest of the eyeball. Within the spatial limits of the anterior surface of the cornea and the ocular surface of the contact lens, a fluid lens is formed. As this fluid is assumed to possess an index of refraction identical to that of the cornea, refraction by the anterior corneal surface is produced, its dioptric value being dependent upon its index of refraction and the radius of curvature given to the posterior optical surface of the contact lens. Inasmuch as the ocular surfaces of the contact lenses are spherical at all times, the newly created substitute cornea will introduce to the eye pencils of light rays which will find convergence at only one point.

There are many indications for the prescription and use of contact lenses—conditions in which experience has shown that contact lenses have a distinct advantage over spectacle lenses. Among these conditions are:

1. Lenticular astigmatism.
2. Conical cornea.
3. Ametropia (myopia, hypermetropia, etc.).
4. Anisometropia, or inequality in the refractive power of the two eyes.
5. Entropion—inward curling of lower eyelids with lashes.
6. Trichiasis, in which there is inversion of the eyelids in such a manner that they rub against the cornea, causing continual irritation of the eyeball.
7. Lagophthalmus—incomplete closure of palpebral fissure when the lids are shut, resulting in exposure of, and injury to, the bulbar conjunctiva and the cornea.
8. Irreparable weakness of sight, for which an enlarging system can be set up by combining a simple convex eyeglass with a strong concave shell acting like the mobile ocular of a telescope.
9. Replacement of forward spectacles on account of the wearer's occupation.
10. "Ophthalmic neurosis," sometimes called "spectacle complex."

Entertainers, professional models, and others whose livelihood depends a great deal upon their appearance prefer to wear contact lenses because they are invisible. Some people, notably many young women, experience feelings of inferiority when they find it necessary to wear glasses. The psychological "lift" that such people derive from wearing contacts is just as important, according to many leading eye specialists, as the actual improvement in vision. This is particularly true of extreme myopes, who can see themselves only dimly without contact lenses. When they look through their powerful concave spectacles, their eyes appear tiny, almost piggish, and they often become quite sensitive about this fancied peculiarity. Only with contact lenses can they see their eyes as they really are. Parents and teachers tell of the almost

miraculous change contact lenses have brought to teen-age girls who had become shy and awkward because of their weak eyes and the necessity for wearing spectacles, which they considered detracted from their otherwise good looks.

THE history and development of contact lenses are as interesting as the techniques now being practiced in the making and fitting of them. Looking down the years, we can see and appreciate the many trials and discomforts, failures and errors, which followed one upon the other before today's techniques were perfected. Experimentation has finally produced a contact lens of finer optics, finer haptics (the science of adjustment to the sense of touch), and greater tolerance than the early investigators dreamed possible.

The contribution of Sir John F. Herschel, an English mathematician, astronomer, and physicist, introduces the story of the contact lens. In 1827, he first suggested the use of a "protective shell" to cover the cornea, protecting it from a diseased eyelid. Herschel devised a small saucer-shaped lens, filled it with a transparent gelatinous substance, and placed it in contact with the cornea to correct regular and irregular astigmatism, conditions which at that time were receiving considerable attention. He had experimented with the taking of gelatinous casts of the eye, but experienced great difficulty because of the fact that local anesthesia was unknown in his day. It was not until 1884 that cocaine was demonstrated to be of practical value in ophthalmic surgery.

The next investigator of the problem was F. A. Müller, of Weisbaden, Germany. He was a well-known eye glass blower and was commissioned in 1829 by a Dr. Saemich to make a thin glass shell similar to an artificial eye, to be used in the right eye of a patient. The physician stipulated that the shell of glass should have a transparent corneal portion in place of the usual iris and pupil, and he used it to prevent ulceration. Müller filled the physician's order, accurately following the specifications prescribed. So satisfactorily did the lens serve its purpose and so expertly fitted was it that the patient wore the shell until his death twenty years later. Müller made several other protective shells for patients. These shells were comparable to those he had been making for atrophied stumps, being for the most part thin, whitish glass shells with fine blood vessels sketched on the scleral portions. Instead of a painted iris and a black spot for the pupil in the center, however, he blew a hemisphere of glass, thin and transparent, through which the patient looked.

Next on the scene we find a noted physician of Zurich, Switzerland, Dr. Eugen Fick, who in 1887 published the results of experiments in which he used contact lenses as refractive devices instead of as mere protective shell coverings. He was the first to use the term "contact lens" (*Kontact Brille*). Dr. Fick experimented with the casting of the eyes of laboratory rabbits with plaster of Paris, had glass lenses blown over these molds, and applied them to the eyes of the rabbits, using various solutions for the liquid lens, finally deciding on a 2 percent dextrose solution as affording the best refractive medium. He further experimented with the eyes of cadavers. From these he had contact lenses blown for his own eyes and reports wearing them without too much discomfort for 2 hours at a time. Satisfied with this, he went ahead making contact lenses for his patients, later experimenting with contact lenses ground to correct visual difficulties, especially cases of keratoconus, a condition in which there is conical protrusion of the center of the cornea without inflammation. To Fick belongs the credit for formulating the idea that the fundamental principle underlying the use of contact lenses was the neutralization of all the irregular astigmatism produced by the conus with a liquid lens of approximately the same refractive index as the cornea, which lens is formed between the anterior surface of the cornea and the posterior, or ocular, surface of the contact lens. In this manner the refractive surface is moved from the highly irregular surface of the cornea to the inner surface of the contact lens with its spherical surface. Fick asked Professor Ernst Abbe, associate of Carl Zeiss, to grind for him a contact lens having a

corneal curvature of 8-mm. radius and a small scleral band of 12-mm. radius. These pioneer Zeiss-made lenses proved unsatisfactory, but Fick, unperturbed, continued with his experiments, records of which reveal attempts to solve some of the clinical problems that even today confront the ophthalmologist in the satisfactory fitting of contact lenses—problems which include such factors as clouding, conjunctival irritations, and tolerance.

August Müller, a medical student at Kiel, Germany, submitted as his dissertation for his Doctor's degree a study of the effects of spectacles on vision, and in that paper he touched upon the subject of contact lenses, with which he had done some work. Independent of Fick and F. A. Müller (to whom he was not related), August Müller investigated the contact lens problem untiringly. He had a Berlin optician grind for him the first contact lens to specification, and was able to correct his own myopia of minus 14 diopters within 0.5 D., although he admitted that the lens was uncomfortable. He attributed the discomfort to poor scleral fit. In 1889, he experimented with the taking of casts from the living human eye, but was not very successful. He did, however, successfully take casts from artificial eyes as a basis for his lenses. These lenses were ground to specifications with varying radii, diameters, and thicknesses, but even with these he was unable to obtain a tolerance of more than 2 hours. In 1889, ophthalmologists had not yet accepted the idea of contact lenses, according to the scientist Joseph Dallos. Many specialists argued that an organ as sensitive as the eye could not possibly be expected to tolerate comfortably the presence of a large piece of glass, when even a tiny dust particle in the eye caused so much pain. They feared that use of contact lenses would cause trauma and subsequent infection of the eye, and were unwilling to take such risks. They were quite content to continue prescribing according to diopters the type of eyeglasses required, instead of experimenting with glass shells of imperfect dioptric effect, which could neither be numbered nor classified.

Another physician, D. E. Sulzer, of Geneva, Switzerland, introduced a new type of contact lens having a narrow scleral portion designed to rest at the outer edge of the cornea where pressure on the limbus often caused pain and sometimes tearing. The corneal portion of his lens was also small. During the period of Sulzer's investigations, in the 1880s and early 1890s, improper design and uncomfortable fit made all contact lenses unbearable after any length of time, and after 1892 the entire idea of contact lenses was abandoned for a number of years. However, the earlier "protective-shell" idea of Sir John Herschel had progressed to an actual contact lens that would correct visual error as long as it could be tolerated. The valuable work of the pioneers demonstrated that the optical principle involved was sound, even though faulty design and fit of the contact lenses at that time prevented their being worn longer than a few hours at a time.

The beginning of the second decade of the twentieth century saw a revival of interest. There were renewed efforts to make contact lenses practical, and many new names began to appear among the investigators of the problem. Until 1932 only the "blown" contact lens by F. A. Müller and the "ground" contact lens first made by Carl Zeiss were described in the literature. Up to that time the lenses used and experimented with were stock lenses, which did not fit—were not made to fit—the individual patient. There was still the problem of finding a material with which to make casts of the human eye. This problem was solved by Dr. Joseph Dallos, of Budapest, Hungary, now working at the Contact Lens Centre, London, England. He has been called the "father of the modern contact lens" because in 1932 he made perfect negative casts of the living human eye with a material known as Negocoll. From the negative mold a positive cast was prepared from a paraffinlike substance called Hominit. Later, as is now done, the positive cast was prepared by pouring dental stone into the negative mold, and these positive casts were then used as a base for the making of the lenses. The latest advance in the making of impressions of the living human eye has been the introduction of alginate compounds, such as are used by dentists for the making of

negative molds. The material has the advantage over Negocoll in ease of preparation, quick setting, and easy removal. For some time wax-casting was tried; a shell of wax was placed between the lids of the eye, and body heat was employed to make it conform to the shape of the patient's eye. After application of ice water, it was carefully removed, and molds were made. This procedure was abandoned on account of its persistent inaccuracy.

In 1939, Dr. Arno E. Town, of New York, whose work is associated with the individual wax-molding method, presented a paper as a graduate lecturer at the 45th Annual Convention of the American Academy of Ophthalmology on "Impression Technic for Contact Lenses." In his report he observed that the newer method of fitting contact lenses by a mold had superseded the previous trial-and-error method, and that stock lenses would fit in about 25 percent of the cases. He brought out the fact that there were so many variations in the shape and size of the sclera and the cornea that it was impossible to attempt a classification of all eyes into a few size groupings.

> The more impressions made of eyes for contact lenses, the more convinced I am that in order to have a good molded glass, it is necessary to have as good an impression as it is possible to make. The better the impression, the better the glass will fit. Furthermore if a technic is used which will help changes to be made in the glasses, work with contact lenses will be more successful [he explained].

The introduction of the all-plastic lens was yet to come in answer to Dr. Town's expressed hope.

In 1934, Gauldi, of Italy, announced an original design for a contact lens with a 20-mm. diameter and with only one continuous posterior curve, eliminating all the various combinations of curvatures for sclera and cornea. His lenses were useful for refraction purposes. In this same year, the Müller-Welt firm, of Germany, which had previously made a lens similar to the Zeiss lens in principle, now made another type of lens, still a blown lens, but blown over toric castings of various curvatures, and fitted by the trial-and-error method.

Until the outbreak of World War II, the Zeiss Company still manufactured their molded lenses. These lenses were made from individual castings and were of glass. In fact, all contact lenses were made of glass up to 1937. In the United States, C. L. Stevens and Dr. W. Feinbloom, of New York, were both making outstanding contributions to the perfection of the contact lens technique. Stevens was successfully using and working with Negocoll, and Feinbloom worked with wax molds of the eye as well as with molds from Negocoll. At this time, Leopold Dreifuss, of San Francisco, was experimenting with molds of an alginate compound he called Modeloid for taking impressions of the anterior segment of the eye. This material set in 3–4 minutes, as against 5–10 minutes required by Negocoll.

The part-plastic and the all-plastic contact lenses made their debut in 1937. In that year, Ernest Mullen, of Boston, made the first all-plastic contacts, and Theodore Obrig, of New York, at first associated with Mullen, began his work with all-plastic lenses, laying the groundwork for his now famous Obrig Laboratories in New York, which specialize in the manufacture of contact lenses, instruments, and supplies for the trade. Feinbloom also became a prominent figure in contact lens work at this time, and during the years 1936–39 he published his method of making glass lenses from individual molds. In 1939, he announced a variation of the same general type of lens, in which the need for casting was eliminated. Both lenses were constructed of two separate parts, a ground-glass corneal portion and a molded plastic scleral band, fitted to each other in much the same manner that a watch crystal is fitted to its supporting bezel.

Albert L. Anderson, associate owner of Precision Contacts Company, Minneapolis, and head of the Scientific Department, N. P. Benson Optical Company; Dr. Edwin Adams, of Detroit; Dr. L. L. Beacher, of New York; and Dr. Eugene Freeman, of Chicago—all are familiar names in recent contact lens experimentation and development.

In fitting the patient with contact lenses,

the eyes are first examined by the ophthalmologist to ascertain whether there are any pathological conditions that would contraindicate the use of contact lenses. The patient's vision is tested and refracted while a pair of trial lenses is being worn, in order to determine the extent of improvement over spectacles that the contacts will provide. If there is little or no improvement, contact lenses will hardly be worth the much greater expense involved, although cosmetic factors may warrant the change if such considerations enter the picture. If patient and ophthalmologist decide on contacts, the technical consultant from the optical company is called in for the taking of the impressions. The patient is placed in a reclining position on the usual operating table or adjustable chair. The ophthalmologist anesthetizes the eyes with 0.5 percent pontocaine or 2 percent butyn, 3 or 4 instillations of 2 or 3 drops each being placed in each eye. There is no pain or danger, and in 5 minutes anesthesia is complete. The molding material, Negocoll, Modeloid, or the more recently developed Moldite, is then mixed by the technician and is placed in the eye, directly over the eyeball. Two molds are usually taken by the more experienced consultants, so as to obviate the necessity of having the patient sit through the ordeal again should one mold turn out to be imperfect. When the semisolid material hardens in 3–5 minutes, depending on the type used, it is carefully removed. From these molds the lenses are made. Then begins the long and tedious process of fitting. The patient has to sit to a series of delicate fittings at the optician's, the lenses being inserted in the eyes, removed, inserted again, and removed time after time by the technician for alterations, trimming, beveling of edges, thinning, further polishing, and other adjustments, all of which is done to ensure perfect fit and comfort. When the technician considers the lenses a perfect fit, he returns them to the ophthalmologist, who, inserting them in the patient's eyes, tests again thoroughly to make sure that the patient is receiving maximum vision from the lenses, adding whatever correction may be necessary before sending them back to the optical technician for final grinding and finishing.

When the new contacts are at last handed to the patient, the optical technician instructs the patient in the care of his contact lenses, how to insert and remove them, the type of buffer solution to use, and so on. Because of the amount of work involved in prescribing and fitting, contact lenses are expensive, costing around $200 a pair, and the patient is strongly urged to insure his lenses against damage or loss.

Regular forward glasses limit the field of correctible vision. When the eyes are rotated, only a small area near the optical center is free of aberrations, and vision is distorted in the peripheral area. Contact lenses, on the contrary, move with the eye. That being the case, the optical center is always before the pupil, and as a consequence the number of aberrations is reduced to a minimum. Contact lenses also offer a practical method of obtaining binocular vision in monocular aphaxia, absence of the crystalline lens of the eye. In general, high myopes obtain much better vision with contact lenses than with regular glasses. The eyes do not appear larger or smaller when contacts are worn, nor are the lenses rendered useless by snow, sleet, hail, rain, or steam, as forward spectacles usually are. Seamen have only to blink their eyes to clear their lenses of spray. People who wear regular glasses are familiar with the fogging caused by steam or during cold weather and can appreciate this particular advantage. Swimmers like them because they protect the eyes when swimming or diving. Actors, actresses, clergymen, public officials, and others use them to hide their defective eyesight and at the same time secure improved vision. Hockey players, ski jumpers, high divers, fancy skaters, hunters, sportsmen, and tennis, baseball, basketball, and football players report that they find them more practical than spectacles because of the increased field of vision, lack of hindrance, and the fact that risk of breakage is practically nonexistent. Mining engineers, whose ordinary glasses become misty from moisture and dust underground, prefer con-

tacts. Industrial workers report that contact lenses afford much more protection against flying bits of steel, glass, and other particles. Flyers who wear contact lenses report that they can now fly open-cockpit trainer planes, or even power-dive from 30,000 feet, without using goggles. Some aviators say they can see far better with contacts at high altitudes than with regular glasses. Along with those engaged in dangerous sports listed above will be found boxers, some of whom actually wear contact lenses in the ring with perfect safety, while seeing their opponents more clearly.

Contact lenses have been found particularly effective as light filters for use on beaches and snowfields, enabling many individuals whose eyes are hypersensitive to light and glare to tolerate such conditions much more comfortably than they could with glasses. Tinted contact lenses are used by lifeguards, skiers, and other persons disturbed by excessive light. Within the past year, Obrig Laboratories announced that a drop or two of a harmless green or yellow dye in the solution filters out painful rays of light without changing the normal appearance of the eyes, thus protecting the eyes against glare and making it unnecessary to wear sunglasses for that purpose.

There are at present three or four main types of solutions used with contact lenses. Some of these are made up to various pH's, and can be made up with different osmotic pressures. Normally, whatever the type of solution used, the osmotic pressure is invariably made equivalent to that of 1.5 percent sodium chloride solution. The solution of choice is the 1.5 percent sodium bicarbonate, which may be used in 1 percent or 2 percent strengths with practically the same good results as the 1.5 percent solution recommended by ophthalmologists and optical consultants. Then there is the sodium bicarbonate-sodium chloride solution made up as follows: sodium chloride, 1.68 gm.; sodium bicarbonate, 0.30 gm.; distilled water, 120 ml. The modified Gifford and Smith buffer solutions are made up according to different formulas, but are all adjusted to give an osmotic pressure equal to that of 1.5 percent NaCl. Table 1 gives

TABLE 1

CHEMICALS TO BE USED WITH 120 ML. OF WATER FOR VARIOUS pH's

pH	BORIC ACID (GMS.)	Na_2CO_3 (GMS.)	KCl (GMS.)
8.0	1.640	0.452	1.056
8.2	1.497	0.543	1.056
8.4	1.332	0.626	1.056
8.6	1.175	0.703	1.056
8.8	1.023	0.777	1.056
9.0	0.874	0.845	1.056

the amounts of chemicals to be used with each 120 ml. of water.

The Feldman buffer solution is another type used with very good results. It is modified to make it isotonic with 1.5 percent NaCl. Table 2 shows the ingredients used.

TABLE 2

FELDMAN BUFFER SOLUTION (120 ML. WATER)

pH	BORIC ACID (GMS.)	BORAX (GMS.)	NaCl (GMS.)
8.0	0.98	1.04	1.01
8.2	0.89	1.21	1.01
8.4	0.80	1.40	1.01
8.6	0.61	1.79	1.01
8.8	0.28	2.47	1.01

It is recommended that the solutions be prepared by pharmacists to ensure accuracy, and that distilled water be used always. Dr. R. R. Tracht, an outstanding ophthalmologist of St. Paul, who specializes in contact lens work, reports that many of his patients who make up their own sodium bicarbonate solution use tap water with no ill effects. However, it is wiser to use distilled water with such precious and delicate organs as one's eyes. Optical technicians further recommend that the solution be prepared fresh every 3 or 4 weeks, in small amounts, say 4 ounces at a time—possibly more often than every 3 or 4 weeks in warm weather and less often in cold weather.

The average length of time that contact lenses can be worn without removal is 4–8 hours. Obrig reports the extreme case of a soldier who wore his contacts for 2 weeks

without removing them. This is an individual problem, however, and only experience can decide how long any individual can wear contact lenses without changing the solution. I find that after I have worn my contact lenses for 4 hours they begin to cloud, and the solution has to be changed. Halos are a phenomenon observed by wearers of contact lenses who do not remove their lenses for 10 or 15 minutes when they first begin to note clouding. Rings of light—wide bands of light—are seen around lights or light sources such as lamps, candles, or even stars and the moon. Some experts explain this halo as being due to the fact that the eye literally "exhales" carbon dioxide—that this CO_2 in the buffer solution will reduce the pH of the solution—and that fact may account for the halos. Immediate removal of the lenses when the halos are noted is of course indicated.

At the present time bifocals are not ground in contact lenses. If necessary, an auxiliary pair of reading glasses may be used along with the contacts. Optical consultants suggest that contact lenses never be wiped with cloth, but that soft tissue of the Kleenex type be used to dry them. Care should also be observed in inserting the lenses to see that the proper lens for the right eye and left eye, respectively, is inserted. Each lens is marked in a corner with one or two small indelible dots to indicate right or left.

Plexiglas, the material from which the nose of army bombers is made, is the type of plastic used in making contact lenses. Plastic lenses last indefinitely—they are unbreakable—and they are 60 percent lighter in weight than glass. The old glass contact lenses were much heavier and in use quite often caused a gravity drop great enough to produce contact with the cornea at the upper limbus. Plastic lenses will scratch more easily than glass, but optically these scratches have no disadvantageous effects, because scratches on the inside surface are filled in by the solution, and scratches on the outside are filled in by the tears. Durability, adjustability, transparency, chemical inertness, and lightness now characterize the contact lenses made of plastic. A well-defined and systematic method of making the adjustments necessary in fitting contact lenses has been gradually developed, and any ophthalmologist, optometrist, or optician with no more than average mechanical ability can be trained to do the work. The State Board of Education in New York, otherwise known as the University of the State of New York, now has under its jurisdiction such a school for giving training in the exacting techniques of contact lens work.

IN THE foregoing pages I have given the reader a description of contact lenses, and the many advantages claimed for them by wearers have been enumerated. It is not the intention of this article, however, to "sell" contact lenses to readers, and it is therefore in order that some of the discomforts, drawbacks, and inconveniences attending their use be pointed out here.

First of all, contact lenses are rather small, and because of that fact they are easily lost or mislaid. Again, there are some individuals who simply cannot tolerate contacts, and such people should not insist on them if a reputable ophthalmologist advises against their use. In fact, under no circumstances should anyone allow himself to be talked into using contact lenses by optometrists or opticians, who, although quite well trained in their specific skills of grinding and fitting glasses to prescription, are neither trained nor qualified to diagnose eye defects or prescribe glasses, regular or contacts. In this matter, the patient should be guided entirely by the advice of his ophthalmologist. The ophthalmologist is a physician—a doctor of medicine who has specialized in diseases of the eye—and is the specialist best qualified to prescribe glasses of any type.

More experienced technicians teach patients how to remove their contacts with the thumbnail as well as with the vacuum cup. Students and younger people generally find it too much trouble to carry the vacuum cup around, and use the fingernail method of removal almost exclusively. The procedure is simple enough. For removing the right lens, the right forearm is raised high, as in the salute position, at right angles to the side of

the head, and in a straight line with the eyebrow. With the eyes looking far over to the left the patient places the back of the right thumbnail on the contact lens, draws it across laterally until the edge of the lens is felt, then puts the thumbnail under the edge near the top of the lens and plucks it forward and out. The left thumbnail is similarly used for removing the left lens. A few minutes of practice soon develops deftness in this method of removal.

The use of contact lenses is, and for some time to come will be, limited, owing to their high cost, the fact that they can be worn for only short periods at a time, and the bother of having to use solutions with them, without which they are utterly useless. Experimentation continues, however, and it is quite possible that a contact lens may yet be developed which will be much easier to insert and remove, will cost much less, and with which probably no solution will be necessary.

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TWISTED TREES

To soilless summits high—
Abandoned by all living things save symbiosts—
The orphaned seeds are borne,
To be rejected by the rocks,
Save some
Who find their succour in the crevices
And sprout.
The cycling seasons claw;
And few remain.
But those whose roots, first tenuous,
Develop varicosities, dig deep
And etch their twisted starkness on the sky.
Before the wind,
With heavy arms and calloused fists,
They stand to battle.

JOSEPH HIRSH

ADVICE TO NEWCOMERS

A REPORT ON RELEASING THE RESULTS OF RESEARCH TO THE PUBLIC

A. J. RIKER, M. R. IRWIN, R. J. MUCKENHIRN, HELEN PARSONS, and M. A. SCHAARS

The authors were a committee (in the College of Agriculture of the University of Wisconsin) assigned to study the obligations involved in releasing the results of research to the public and to indicate the best way to do it. The faculty adopted their report unanimously. Although it was prepared for a single institution, the report appears here because it contains much that may interest others.

THROUGH emphasis on learning and service, a cooperative and highly beneficial understanding has developed over the years between the state of Wisconsin, the College of Agriculture (including the Department of Home Economics), and the people of the state. Because of the interweaving of its activity with man's economic and personal welfare, this College of the University of Wisconsin has established many happy relationships and has made every Wisconsin citizen, whether farmer, public official, or industrial magnate, feel welcome while seeking help with his specific problem. When a citizen wishes to improve his own situation or that of his community, he can secure advice from the College. If inadequate information is available, a problem of critical importance may be investigated by the faculty.

Thus the College is the chief of the state's agencies to encourage, to assist, and frequently to lead ambitious and forward-looking agricultural people to improve their general welfare. In a very real sense, the limits of the College campus are the boundaries of the state.

The freedom and opportunity provided for the faculty have given it large obligations and enormous responsibilities. The splendid traditions of service to the public and of cooperation with one another are among its most cherished possessions. In the highest sense of the word, the faculty members are servants of the state. Among them, highest honors go to those who have served the public well. To be worthy of their trust is no small concern of these men and women.

However cloistered some theoretical and technical phases of agriculture may be, they belong in the science of life and they affect the food, shelter, and general welfare of every Wisconsin citizen.

After the answers to critical problems have been painstakingly worked out, the results verified, and the implications fully understood, there is an imperative obligation to make the new information available to the public promptly and to indicate what good might be achieved as a result of the work. Such releases that are premature, however, or that are made inappropriately, can be detrimental to the investigator, to the institution, and to the best interests of the state.

Technical matters are usually announced through lectures before scientific societies, in research journals, or in Experiment Station publications. The more popular accounts are made available by means of the press and radio and in meetings and classrooms.

Primarily for the benefit of new members added to the college faculty, some of the traditions and obligations of the staff regarding both the conduct of research and the announcement of the results are indicated below.

Safeguarding academic freedom. In accord with the regent's report in 1894, it is essential to keep the College of Agriculture, as part of the University of Wisconsin, a place where the mind is free to serve the best interests of mankind, where it bows only to the commands of an exacting conscience, and where there is the "continual and fearless sifting and winnowing by which alone the truth can be found."

Among the basic principles of academic

freedom are the following (copied, in part, from the statement in *Amer. Ass. Univ. Prof. Bul.*, 1944, 30, 104–105):

> *a*) The investigator is entitled to full freedom in research and in the publication of the results, subject to the adequate performance of his assigned duties.
>
> *b*) The speaker or writer is entitled to freedom in the classroom or before the public in discussing his subject, but when serving in a technical capacity he should be careful not to introduce controversial matter which has no relation to his professional field.
>
> *c*) The university man is a citizen, a member of a learned profession, and an officer of an educational institution. It is not to be believed, or even assumed, that a scientist has any special capabilities in questions well removed from his special subjects. When he speaks or writes as a citizen, he should be free from institutional censorship or discipline, but his special position in the community imposes special obligations. As a man of learning and an educational officer, he should remember that the public may judge his profession and his institution by his utterances. Hence, he should at all times be accurate, should exercise appropriate restraint, should show respect for the opinions of others, and should make every effort to indicate that he is not an institutional spokesman.

Since being worthy of academic freedom is the best means of maintaining it, some of the obligations of the staff are indicated.

Responsibilities of investigators. Mature scholars working together for the development and utilization of knowledge form the foundations of our civilization. Few things can be more important than to enhance and maintain the dignity of the investigator's profession so as to attract into its ranks and to hold men of highest ability, of sound learning, and of strong independent character. Such men have special obligations to one another, to their institution, and to the public.

Important among the responsibilities of those doing research are the following:

a) The highest standards of investigation, interpretation, and release of information to the public are obviously necessary. The policies, procedures, and achievements in each program may be evaluated best by giving first importance to their effectiveness in promoting the research project in hand, its publication, and the public welfare. Purely personal aspects or the roles of individual workers are secondary.

b) Because of the many factors involved in any important program, every effort should be made to emphasize the subject itself rather than the activities of particular administrative units. An environment is to be encouraged in which there is the greatest possible freedom for cooperation between individuals irrespective of budgetary divisions involved.

c) Decisions regarding important technical matters are wisely made only after all those interested have had the opportunity to express their views. The decisions should be unanimous before action is taken, before recommendations for practical applications are given, and before the results are published. It is particularly unfortunate when two scientists give the public conflicting advice. It is to be expected that there will be differences of opinion. Controversy in science is healthful, but its place is on the campus and in scientific journals, rather than in the popular press or in the talks before general audiences. If differences of opinion are so strong that individuals are unable to agree, such differences can be settled (1) by ending the undertaking, (2) by the withdrawal of one faction, or (3) by calling on the services of an umpire selected by mutual consent.

d) Any publication of important new research sponsored by the Experiment Station must have the approval of the director.

e) The results of research should be released only after an exacting scrutiny has shown that the experiments are valid and that the conclusions drawn are the only ones justified. Ordinarily, the work should be criticized by two qualified colleagues who did not participate in the study.

f) The release of technical or institutional information without the knowledge and approval of the responsible investigators and administrators is a breach of confidence and contrary to the best interests of the staff and the public. The privacy of conferences and of the papers sent through the campus mail deserves respect.

g) If someone on the staff should gain important information in any manner and

should release it prematurely with resulting embarrassment to the faculty, the institution, and public relations, the situation calls for investigation by a special fact-finding and duly constituted committee of the faculty.

h) When discussions are called for about controversial questions, a worthy man presents impartially the evidence on both sides.

i) Discussions regarding the results of one's own research and those of other scientists are in bad taste when personalized and in good form when objective.

j) Disparaging remarks, especially before students or the public, commonly boomerang to the disadvantage of the speaker.

k) When valuable results have been satisfactorily proved and are ready, they should be made available to the public as promptly as feasible. It is recognized that when the work is reported, either through the printed page or from the platform, it becomes public property.

Recommended procedure. For all ordinary situations with new material, the following course of action seems desirable:

a) The first public statement of a major research finding should be through an approved manuscript or through a communication before a scientific society. Almost simultaneous release can be arranged for press and radio.

b) When popular releases are provided, they can be made, for example, through the staff of the Department of Agricultural Journalism, so that all the news agencies of the state will receive the story at the same time. The prepared account should be carefully checked for accuracy by the investigator.

c) Newspaper reporters and correspondents for magazines often are anxious to secure prior announcement of important findings for the exclusive use of their own publications. Such "scoops" can be disastrous from the public-relations standpoint. Every editor who sees a rival thus obtain important information has a right to complain. The College can lose more good will through a scoop than it can gain in credit from one publication. It cannot afford to play favorites among the gentlemen of the press.

The same principle applies when new animals and plants or when new technical procedures are developed. They are made available in as impartial and equitable a manner as possible so as best to protect and serve the public interest.

d) Occasionally, an avid reporter does obtain more or less distorted information not yet authorized for release. If this should happen, it is wise to consider with the administration and the Agricultural Journalism Department the desirability of heading off the impending scoop by an accurate and prompt release to all papers.

e) However, when correspondents seek additional information about material already announced, it is desirable to accommodate them so far as seems feasible. In such cases, there is no reason to consult the administration or the Agricultural Journalism Department. Likewise, no approval is necessary when members of the research staff write clarifying articles for popular publications or speak over the radio. They wisely utilize such opportunities to round out the public's information, so long as it does not involve exclusive release of original research.

f) Scientists giving important speeches before popular or technical societies or publishing valuable technical papers should take the initiative in providing for and correcting popular releases with the press service available on the campus.

g) None of the cautions mentioned above should put off or impede the prompt and adequate release of significant information about progress in research. More investigators commit sins of omission than of commission. Those in publicly supported institutions have a special responsibility against unnecessary delay.

In conclusion, while releasing the results of research, the best way for research men to safeguard their academic freedom is to be worthy of it. From the nature of their positions they have a large and exacting responsibility to their colleagues, to their institutions, and to the public welfare.

TECHNOLOGY AND COMMUNITY: THE MANDATES OF SURVIVAL

MELVIN RADER

Dr. Rader (Ph.D., Washington) began his teaching career in the English Department of Western Reserve University. Within a year he had decided to transfer to philosophy; he has been teaching it since 1930, currently at the University of Washington. Dr. Rader is the author of A Modern Book of Esthetics.

AT THE dawn of modern science, men were immensely confident that its uses would be beneficent. The great medieval seer, Roger Bacon, was fired by a deep enthusiasm for the new world that science would create. It would reveal the past, present, and future, and secure the vast improvement and the indefinite prolongation of life! Similarly, such Renaissance thinkers as Giordano Bruno, Leonardo da Vinci, and Tomasso Campanella—harbingers of the modern scientific and technological revolution—were intoxicated with its infinite promise. Such optimism found ample expression in the work of Francis Bacon, who believed that science would enlarge "the bounds of the human empire to the effecting of all things possible," and, in writing the *New Atlantis,* jubilantly imagined the Utopia he believed scientific progress would achieve. Another great prophet of science, René Descartes, looked forward to the time when we human beings would understand "the force and the action of fire, water, air, the stars, heavens, and all other bodies that environ us, . . . and thus render ourselves the masters and possessors of nature." The same confident note is struck again and again in the writings of the great Renaissance scientists such as Kepler and Galileo.

It is sad to turn from such inspired optimism to the views of some more recent thinkers. Ironically, it has been within the past hundred years, when science has been achieving its greatest triumphs, that the most pessimistic views have been expressed. For example, Marx maintained that science and technology, in the absence of a sound economic structure, only intensify the insecurity and misery of life. "Even the pure light of science," he said, "seems unable to shine but on the dark background of ignorance. All our inventions and progress seem to result in endowing material forces with intellectual life, and in stultifying human life into a material force." The more pessimistic American thinker, Henry Adams, wrote at the beginning of this century:

> I apprehend for the next hundred years an ultimate, colossal, cosmic collapse; but not on any of our old lines. My belief is that science is to wreck us, and that we are like monkeys monkeying with a loaded shell; we don't in the least know or care where our practically infinite energies come from or will bring us.

Likewise, William James, although not given to dour predictions, warned that natural science might culminate in the total destruction of civilization, and that modern scientific man may be like the child drowning in a bathtub because he has turned on the water without knowing how to turn it off. Since the development of atomic fission, not only philosophers and social theorists but even the most eminent scientists have become alarmed. Professor Harold C. Urey, a Nobel prize winner in physics, has declared: "I'm a frightened man. . . . All the scientists I know are frightened—frightened for their lives—and frightened for *your* life."

What accounts for this difference between the early optimistic prophets of science and these latter-day "alarmists"? The explanation, in part, is that bitter experience has taught men a simple truth—that every science and technique can be used for either good or ill. Knowledge of drugs may be used to heal the sick or to poison one's enemies; military art may be used for legitimate defense or ruthless conquest; economics can be used to swindle or to aid; education may inculcate base ideals or true wisdom. Hence, it is very important to choose the proper goal.

As Francis Bacon remarked: "The lame man who keeps the right road outstrips the runner who takes the wrong one. Nay it is obvious that when a man runs the wrong way, the more active and swift he is the further he will go astray." A society, like a runner headed in the wrong direction, may be efficient and yet damned. Hitler provided the most vivid illustration of this contention. With the technical resources of a highly civilized ruler but with the moral impulses of a barbarian, he was able to wreak havoc beyond the wildest ambitions of an Attila. Hell may be paved with good intentions, but it is also paved with science and techniques. Was it not to *know* more that Faust answered the devil's call?

We must, therefore, have sound ideals to determine the uses to which science shall be put. During the dawn of scientific thought, when glorious new horizons were becoming visible, it was easy to overlook this fact; but we who live with the *Blitzkrieg* fresh in our memory are fully aware that science can be used either to construct or destroy.

In the present article, I shall maintain that nothing short of the ideal of community, as embodied in a cooperative social order, can guarantee the utilization of science for welfare. When I speak of "community," I am using the word in a broad sense. Some writers, such as Baker Brownell, insist that the term should be reserved for the small, intimate, face-to-face group, such as the old-fashioned "neighborhood." Other writers, such as Josiah Royce, use the term to denote any essentially cooperative group, even though world-wide in scope. I shall use the word to cover both these meanings; and, indeed, I shall argue that we need both the *intensity* of community as insisted upon by Brownell, and the *extensity* of community as envisaged by Royce.

The need to integrate science into the wider life of the community becomes obvious when we consider technology—the instruments and techniques that spring from applied science. Because of the ever-accelerating technological revolution, including the development of atomic fission, men's ability either to cooperate with or to injure one another has become exaggerated beyond all comparison with former times. As this process of change rushes toward a climax, the sole way to avoid dire catastrophe and to reap the immense potential benefits of the new technology is to organize a world community among the medley of separate sovereign states, of antagonistic races, of embattled economic classes. As the atomic scientists have told us, it must be *one world* or *none*. It must be a unified and peaceful world or it will eventually cease to be a decent world, a human world.

At the same time we build a world community, however, we must not neglect the small community, without which the great community will lack roots and reality. We cannot create a lasting world community unless we reconstitute and conserve the values of the intimate neighborhood—the love that comes only with intimacy, the appreciation of personality in its wholeness and integrity, the sense of mutuality and interdependence. Technology as we have known it in the past hundred years has been lethal to these values. It has substituted the standardized routines, impersonal relations, fragmentary contacts, and rapid shifts of an anonymous mass society. It has thus tended to undermine the person-centered culture which alone has nourished the ideal of the brotherhood of man.

In this article, I shall consider the relation of technology both to the small primary community and to the great community.

No PHASE of technology has been more disruptive of primary group life than the development of mobility and communication as a result of modern inventions. People dart about by means of trains, ships, busses, trolleys, automobiles, and airplanes in a manner that would have been incredible fifty years ago. Likewise, a startling revolution in communication has been produced by the rotary press, linotype, telegraph, telephone, phonograph, camera, radio, moving picture, and television and by the multiplication of museums, libraries, postal facilities, educational institutions, and publicity and propaganda agencies.

Mobility shifts the individual relative to his environment. Communication, in a sense, shifts the environment relative to the individual: it brings the distant in time and space into the immediate focus of attention. The effect of both mobility and communication is to weaken or dissolve the old neighborhood unity. Essential contacts are often not immediate: they are five miles away at the club, downtown at the office, a hundred miles distant in a different city. A person may be swayed far more by a writer in Paris than by the man across the street. In the metropolitan environment, where mobility and communication are most highly developed, the main direction of human attention has shifted to unstable contacts, remote influences, and dispersed currents of thought.

This effect has been reinforced by the economic fluctuations and world wars that have been characteristic of our technological age. The greater part of the world has rocked on from crisis to crisis: from war to boom and then to depression and to war again; and this fatal cycle threatens to begin anew. These inflations and depressions have hurled millions out of one stratum of society into another; they have left a great many people with a sense of undeserved frustration and a diminished faith in the old verities. As a result of war, too, the pattern of living has been rudely marred; habits, ambitions, ideologies, have been scrapped; new programs of life have been swiftly improvised. Almost everyone has experienced to a degree how violently the personality is wrenched by these social transitions. Technology cannot be held exclusively responsible for these developments, but they could occur on a huge scale only in a technological age.

Even the mere frequency of inventions has a disturbing effect upon the folkways of the old neighborhood life. Modern inventions are not only numerous but are increasing at a fast, cumulative pace. Most of these inventions are unpredictable, and a great many of their effects are unforseeable. Consequently, men cannot prepare for the unknown future, and they find that the old ideas and prophecies do not apply. They feel bewildered, as though they had awakened after a severe earthquake to find the old landmarks scarcely recognizable.

The cumulative effect of these factors—mobility, communication, economic insecurity, modern technological warfare, and frequency of invention—is a disorientation more radical than the world has known for many centuries. When the mind is subjected to rapid shifts in time, space, rank, and expectation, impressions are multiplied beyond the individual's power of synthesis. Faced by this disjunctive multiplicity of experience, many minds have floundered in their effort to achieve life organization. The technological revolution has transported them to

> . . . . the waste beyond God's peace
> To maddening freedom and bewildering light.

The quiet, intimate, stable pattern of the small community or family group has, in consequence, been severely shaken.

No doubt the restless and sophisticated man of today is posterior in point of evolution to the stable "Philistine" type of the old-fashioned neighborhood and primary group; he is possibly higher in scale of "intelligence" and certainly wider in range of experience. Others besides Marx have spoken of the "idiocy" and dullness of rural and village life. Most city dwellers, indeed, would be reluctant to leave their cramped quarters for the more spacious and beautiful environment of the small town or countryside. To some extent, their reluctance is the result of a kind of blindness, like that of the city dweller who takes a portable radio when he goes into the country for an "outing" lest he feel bored in contact with earth and sky without the commercial advertising and continual mechanical din of the radio programs. On the other hand, many people have good reason for their reluctance to leave the great city. It affords more opportunity for varied experience, critical choice, purposive association, and many-faceted cultural experience. The small, relatively static community, in contrast, has less stimulus and challenge, less dramatic appeal, more stodgy conservatism, more intolerance toward variations in personality.

Life in the metropolitan environment, how-

ever, is now becoming so congested and hectic, so routinized in its mechanical regimens, so casual in its human contacts, that relatively few of the inhabitants can find any deep happiness or intimate companionship. The happy life, like music, has its melody and its harmonic background, its essential motifs and subsidiary phrases, evolving in an orderly and continuous pattern. Such organic development of personality occurs only when there is a considerable degree of organicity in the stuff of experience, whereas the environment of the machine-age man is disorganic in its confusion, profuse novelty, fragmentation of experience, and mechanized routines. The high rates of crime, juvenile delinquency, insanity, and suicide in the great urban areas are one indication of the human toll that is being exacted.

Congestion in these overgrown cities is paralleled by depopulation and anemia in the countryside and the villages. Wherever modern technological civilization is highly advanced, talent, wealth, and population are being drawn off from the small towns and hinterlands to the metropolitan centers. Vast rural expanses have become, in effect, economic and cultural colonies exploited for urban advantage. The more educated and energetic of the youth float away to the city, never to return. Spengler finds in such devitalization of the countryside and smaller communities, with its attendant metropolitan concentration, one of the surest signs of the "decline" in civilization; and both Patrick Geddes and Lewis Mumford have vividly described the social decay that sets in when cities reach the stage of extreme congestion and giantism while the surrounding hills and valleys and towns are drained of their human wealth.

It is doubtful if the ideal of the brotherhood of man, which even now is honored more in the breach than in the observance, can be long sustained in this metropolitan environment. Modern technology and its giant spawn, industrialism, have so atomized human relations, so specialized human activities, so externalized human contacts, so entangled human nature in a net of technical functions, that the loving, intimate, comprehending relations of man to man have given way increasingly to the hostile, abstract, uncomprehending relations of "pressure groups" and mass organizations one to another. A face-to-face community, in contrast, is required for the appreciation of personality in its fullness and integrity.

As an illustration of the callousness of people in a great city, I might cite an Associated Press dispatch from Chicago dated August 13, 1947. It tells how a man was waylaid and robbed and then left late at night in an area of cheap bars and flophouses, to stumble along barefoot, shirtless, gagged, and with hands bound. He wandered into one saloon and then another to secure aid. In each case, the bartender took one look and ordered him out. He then approached a couple walking along the street and, with the gag in his mouth, tried by a pleading expression on his face to enlist help; but the two passers-by walked briskly away. Finally, he managed to work loose his hands, removed his gag, and went into another saloon to tell his story. The bartender, who consented to listen, tossed him a nickel to call the police. This misadventure, although extreme, illustrates the indifference—the lack of sympathy and understanding—that only a great city can breed.

It stands in contrast to the sense of the preciousness and intrinsic dignity of personality which our civilization has so largely lost. We remember, as if from another world, how a crisis that churned France to its depths resulted, in great part, from the mistreatment of a single Jew, Alfred Dreyfus. It is even harder to realize that, prior to the first world war, civilized people throughout the world became incensed when a German officer in Zabern brutally attacked a lame cobbler who refused to yield the sidewalk; and that the German Reichstag, because of this military arrogance, censured the government by a vote of 293 to 54. What a vast chasm there is between such intimate concern for human personality and the incredible mass sadism of Buchenwald and Maidenek! The fascists' degradation of human beings to the status of things, their cruelty and contempt for life,

is an extreme expression of the mass anonymity of a depersonalized civilization in which the relation of men to machines outweighs the relation of man to man. There are many causes of fascism in addition to mechanization and urban overconcentration; but the tendency to be callous toward human beings, so pathological in the case of fascist behavior, is endemic to a highly urbanized and technological civilization in which human contacts are casual, fragmentary, psychologically remote, and sometimes deliberately cruel.

If we are to regain a keen sense of human dignity and worth, we must somehow reconstitute the small face-to-face community. There is no other environment that can nourish the intimate values of life. In such a community, whole human beings are related to other whole human beings; they know each other well. In a great city, on the other hand, people know one another, for the most part, only in fragmental, partitive relations—as abstract, anonymous, voiceless entities in massive impersonal aggregations where the sense of human fellowship is lost. All the great religions of human brotherhood, it is worth remarking, have sprung from a pretechnological, preindustrial, primary group life, and they have always expressed themselves in the language of that life, such as "the brotherhood of man under the fatherhood of God." Even democracy, as a system of values, is dependent upon sympathy, mutual aid, and the warm appreciation of personality—upon attitudes, in other words, that can flourish only in intimate and direct associations.

If democracy and human brotherhood are to survive, if the very future of mankind is not to be jeopardized, we must remaster the machines that have mastered us. By means of humane and democratic planning, we must guide technological trends, counteract some and encourage others, so as to reconstitute and conserve the small intimate community. No sensible person would wish to demolish the metropolis or the technology that has produced it; the city will always have an important function, and many people will find it congenial. What one should object to, however, is the lack of balance in modern life: the hypertrophy of urban congestion and cosmopolitanism and the atrophy of communal sympathy and local creativity. In the task of reconstruction, nevertheless, it is just as important to bring to the small community the real advantages of city life as to introduce into the city the quiet and more intimate ways of rural life. These two sets of values, metropolitan values and community values, must become more interpenetrative. Modern technology must be redirected into channels favorable both to the decentralization of the city and the cosmopolitan broadening, and thus the enrichment and strengthening, of rural and small-town life.

The present inhuman concentration of activities keeps on apace because the smaller communities are relatively incomplete; but there are already signs in the evolution of technology itself that this incompleteness can be removed. With the development of rapid transit, the labor supply can be more freely dispersed: the workers need not live in the squalor of overcrowded areas near the industrial plant; and people can have access to the city and its metropolitan services without living immediately in the city. Moreover, new methods of converting common materials to industrial uses are making every back yard a potential source of wealth: perhaps soon we shall be making most of our aluminum from the common clay of the soil, or be manufacturing plastics and many other synthetics from vegetable products grown on the farm or from the ordinary materials of the earth. Also, the technological aids to living—automatic heating plants, mechanical refrigerators and deep freezers, electric washing machines, radios and phonographs and television sets, small power tools, etc.—are making the home establishments and the neighborhood community relatively complete and independent. The development of local theaters, libraries, educational and cultural centers, and outlying shopping facilities can do a vast deal to enrich life in these new decentralized home areas. With the modern development of transportation and communication, moreover, greater choice can be exercised in setting up intimate communities:

like-minded and congenial people can flock together and can organize the community life in accordance with their mutual interests. Thus, the limitations imposed by the size and isolation of the small community can be, and to some extent *are* being, removed by technological and cultural advance.

A very important factor in this movement toward decentralization is the development of new sources of power—electric and atomic. When electric power becomes fully exploited, its inexpensive conductivity will greatly reduce the aggregation of industries near coal fields and transportation centers; it makes industrial production in the small town feasible. Military considerations, connected with the release of atomic power, may in time give an immense impetus to decentralization, since the concentration in huge cities enormously increases vulnerability to air attack, including the atomic bomb. One advantage of atomic power, when applied to constructive peacetime uses, is that the small bulk of the uranium or plutonium from which the energy is derived reduces the difficulties in the distribution of fuel and therefore permits the location of power stations in scattered areas near the consumers. This feature makes possible the industrialization of regions now unsupplied with coal or water power, where the absence of a power supply at the present time presents prohibitive difficulties. All these factors make for a decentralized economic and social structure.

Enough statistical evidence is already at hand to show that technology is, in fact, beginning to create a new type of social organization—less centralized, less congested, less impersonal, and less bureaucratic: that the centripetal city is giving way to the centrifugal city and the small community. Under the influence of automobiles and other forms of rapid transit, suburban villages and outlying trading centers are multiplying, and some of the smaller towns are beginning to revive.

In response to these trends, there has sprung up a number of writers and thinkers—a group of decentralists: men like Arthur Morgan, David Lilienthal, Baker Brownell, Frank Lloyd Wright, Lewis Mumford, Ralph Borsodi, and Paul Meadows. They believe that the new technological trends toward decentralization can be greatly stimulated by social planning and community organizing. They find a practical demonstration of some of their theories in the great T.V.A. experiment, with its decentralized type of administration and its use of an advanced technology in behalf of the smaller communities. They hope eventually to reestablish a person-centered culture and an intimate neighborhood life upon the basis of the new technological trends and the rich resources of modern life. Some of the "decentralists," such as Ralph Borsodi, have gone to reactionary extremes in deriding the machine and denouncing mass production and distribution; but others wish to turn ahead rather than turn back the hands of time.

THE reconstitution of the small community, however, is but half the problem. The organization of the "great community"—the international accord of all peoples—is no less imperative. Unless men in the small community learn the values of love and intimacy, and unless they extend the good will thus acquired to all nations, technology will prove lethal to civilization.

Everybody, in a sense, lives two lives—one life in a small, and the other in a great, circle. He is a member of various intimate groups—the family, the neighborhood, the occupational association, the cluster of friends. But he is also a member of a whole national society and, in the modern world, he is living within an interdependent system of nations. We cannot regard the national or international society with the same intimacy, the same loving concern and warm appreciation, that we naturally feel toward our friends and intimates. Yet certainly our life in each of these circles is modified by our life in the other. Our attitudes toward great national or international issues will strengthen or weaken our friendships or other intimate ties. Likewise, the cultivation of love and sympathy in the small community will necessarily affect our capacity to feel good will at greater remove from our-

selves. It has always been the teaching of Christianity and other ethical religions that the feelings of the "good Samaritan," although nourished in the small community, can be extended to a much wider circle of human beings. No doubt there is a profound qualitative difference in our respective attitudes, but in a certain sense we can "love" not only our friends but all mankind.

It is in this wide sense of the word that Auden writes in one of his poems: "We must love one another or die." A decade ago this line would have sounded melodramatic, but it is now merely realistic. The facts are indeed stark, and although familiar, bear repeating. The scientists who made the bomb, the authorities who know it best, are agreed about certain essential facts. Most of the principles involved are no secret; apparently, any nation with a considerable body of competent scientists can in a few years learn to make it. No effective defense is possible: if only a plane or two gets through the antiaircraft defense, or if only a few bombs are planted by enemy agents, the destruction will be colossal; and, in the event of a surprise attack, the major damage can be done before the defenses can be mobilized. A single "improved" atomic bomb can devastate ten square miles of a city. Ansley J. Coale, in a comprehensive analysis of the social and economic consequences of the bomb, prepared under the auspices of the Social Science Research Council, has estimated that a concerted surprise attack upon the United States might result in fourteen to seventeen million deaths in a single day or even in a few hours. Einstein has estimated that in an all-out atomic world war, with both sides thoroughly equipped, two-thirds of all mankind might be slaughtered. I shall not discuss the even more dire prophecies, for example, that an atomic war would so poison the earth and the atmosphere that it would leave vast continental areas uninhabitable.

Other weapons may be no less deadly. Radioactive poison gases can be easily made as by-products in atomic-bomb plants and may rival the bomb in lethal efficiency. Another type of poison can be made in the biologist's laboratory; and it is much more controllable than any bacteriological weapons that could have been produced in the past. Until recently, biological warfare has been too dangerous for any nation to utilize, since an epidemic deliberately spread by the wholesale dispersion of germs might sweep the enemy like a scourge but probably would also sweep the world. Now, however, scientists have learned to separate inanimate poisons produced by germs from the germs themselves. The botulinum toxin, for example, is a by-product of butolinus spores; it can be used to spread death throughout enemy territory, by poisoning the water or food supply, without the risk of a world epidemic. These new poisons made by germs are much more powerful than anything made by man, and are lethal in almost infinitesimal quantities. Moreover, newly developed fire bombs, used as warheads in rockets or guided missiles, may be a weapon almost as sudden and decisive and deadly as the atomic bomb or the biochemical poison. With the use of advanced methods of saturation bombing, these incendiary weapons, containing a gelatin compound that defies normal methods of fire fighting, can be used to send up in flames great harvest areas and forests and cities. Such considerations led General H. H. Arnold, a hard-headed military man, in his last official statement as head of the Air Forces of the United States, to declare that "the only hope for preserving the values of our civilization" lies in the prevention of war. Similarly, Dr. Vannevar Bush, the director of the Office of Scientific Research and Development, has remarked that "non-atomic weapons which were under study, in preparation, or in existence when atomic bombs ended 'the recent war' could by themselves when fully developed obliterate civilization."

In the past, there was always the danger that some particular group or society would go astray; but now there is the danger that mankind itself will miss its way. Civilization, once so solid, appears fragile as an eggshell. After fighting a war of unimaginable horror, after inventing weapons of incredible deadliness, the nations are plotting, blundering, and drifting toward a war far more dreadful than the last. If war follows war, the finis may be universal genocide.

War cannot be prevented if, because of so-

cial injustice and the hatred that it breeds, creed is pitted against creed, race against race, class against class, *within* and not only *among* nations. For the peoples of the world are now interdependent; technology has so shortened distances, so interwoven lives, that a profound internal crisis, such as existed in Germany during Hitler's rise to power, endangers the peace of the world. In a very real and terrible sense, therefore, we are all our brothers' keepers.

THE potentialities of modern technology, however, are by no means simply destructive. This fact is emphasized by the chairman of our Atomic Energy Commission, David Lilienthal, who has made the following comment upon the destructive powers and the constructive opportunities provided by atomic fission:

> Look—this thing is tough. It is grim. It is not a happy experience to be living with a nightmare. But we must talk about it as mature people and not react like children to a horror tale at bedtime. Let us see what we can do toward insuring against atomic warfare, rather than waste our energies fearing the threat of it. Let us see to it, too, that the shadow of the bomb does not blind us to the scope of atomic development as a potential blessing to mankind.

This is sound advice. We need sober thought and quiet determination rather than hysteria; and we need to recognize the great constructive potentialities of modern science and technology. If men make proper use of the forces that are being unleashed, their destiny will be glorious rather than terrible.

Scientists are now penetrating the heart of the atom; they are engaged in the most fundamental discoveries; and just as basic discoveries led to profound technological changes in the past, so these new discoveries can be expected to produce like changes in the future. The study of molecules gave us chemistry, with its innumerable beneficent applications; the study of electricity and magnetism gave us the vast electrical industry, with its immense contribution to the power and convenience of living; the study of bacteria gave us germicidal medicine, with its great extension and improvement of life. Now scientists have made this new discovery of atomic fission, the most basic discovery, some experts have told us, since man learned to produce fire. Surely the results of this new fundamental research will also be very great. As a recent writer, David Dietz, has remarked: "Unbelievable as is the atomic bomb, it may bear the same relation to future manifestations of atomic energy as the 'electric machines' of Benjamin Franklin's day bear to the hydro-electric generators of Boulder Dam." If not perverted to evil ends, this future development of atomic energy will be very good. We are so gripped by fear that we all tend to think of atomic fission as a weapon of death, but actually its peaceful development promises a future of abundance for mankind.

In other respects, also, technology is striding forward with seven-league boots: in the development of electronics and synthetics; in food chemistry and medicine and sanitation; in the application of psychological insight to mental illness; in the invention of innumerable cunning machines. Relatively retarded are the social techniques—the methods and devices of the educator, the economist, the statesman, the community planner; but even in these fields there is a remarkable creative ferment, a vast deal of experimentation. It may be, as some authorities have told us, that science and technology have been merely rehearsing and that the real play is yet to be enacted. It may be that we are trembling on the verge of a new technological revolution that will dwarf any in the past.

The constructive potentialities of applied science, however, cannot be fully visualized unless we consider its relation to other cultural factors. Science operates within a vast complex of interdependent forces that cannot be neatly and simply described; but perhaps the most fundamental aspect of this many-sided process is the interplay of inventions and traditions. An invention is the contrivance of something new, and a tradition is the preservation of something old. In our scientific age, inventions are predominantly the machines and techniques that spring from applied science. Traditions are the institutions, ideologies, and forms of behavior inherited from the past. These two factors, the one relatively dynamic and the other relatively static, are variously related: the tradi-

tions fetter the inventions; or the inventions disrupt the traditions; or either one perverts the other; or they condition and transfigure one another; or the force released by an invention may put an unprecedentedly powerful drive into some traditional institution or mode of action.

As a result of inventions, the techniques of transit and communication, for example, have developed with extraordinary swiftness and have collided with the traditions of the parochial community and the absolute nation-state. The speed of transit has markedly accelerated only in the past hundred years. The previous rate of travel may be illustrated by Napoleon's headlong flight from Russia. Despite the fact that he deserted his army and sped forward as rapidly as he could, it took him three hundred and twelve hours to traverse the distance of fourteen hundred miles from Vilna to Paris. This meant an average of less than five miles an hour. One of Napoleon's contemporaries, Lord Byron, loved speed and wrote about it:

> Now there is nothing gives a man such spirit,
> Leaving his blood as cayenne doth a curry,
> As going at full speed.

Yet full speed for Byron was the gallop of a horse! A radical change was dimly in sight when the first practicable locomotive surprised the British population in the year 1829. By the end of the nineteenth century the velocity of transit had become "startling." Henry Adams felt that the automobile, in its development from 1893 to 1900, "had become a nightmare at a hundred kilometres an hour": yet the automobile of 1900 would, of course, seem very primitive and poky if we had to use it today. The main acceleration in speed, therefore, has occurred in the twentieth century, reaching its climax in air travel that now approaches the swiftness of sound.

It is possible to trace a similar revolution in communication likewise achieved for the most part in this century. Beginning with relatively slow methods of transmission such as the pony express, communication has accelerated until it has reached its upper limit, the speed of light, and this ultrafast method is now, by means of the radio, available to almost everyone.

What has been the impact of these inventions upon the parochial community and the absolute nation-state? Several things have happened. First, intervals and distances have been so greatly abbreviated, and the parts of the world have become so interdependent, that the old parochial divisions, ethnic and geographic, have suddenly become obsolete. Second, these new technological circumstances, although they have made the exclusive racial community and the "sovereign" nation-state anachronistic, have also immensely reinforced their drive and power. For example, if it were not for modern methods of communication such as the radio and the movies, the fascists could not have employed such terribly effective propaganda to intensify racial and nationalistic bigotry; and without modern methods of transport such as the tank and the airplane, they could not have waged a totalitarian war. Third, the parochial traditions, in turn, react upon the wonderful new inventions of communication and transport, warping their application. Peace-serving inventions are fettered and strife-serving inventions are stimulated. The development of military aviation, for example, has taken precedence over the development of civil aviation. Fourth, the new techniques of communication and transport, though they contribute to the senile flare-up of parochialism, also challenge, disrupt, and displace the obsolete traditions and strengthen the opposing forces of internationalism and interracialism. The ideal of the United Nations is rendered cogent and practical by the very technological developments such as the airplane that made possible Hitler's assault upon civilization. To the extent that communication and rapid transit undermine the intimate, face-to-face community, they are striking at a very essential ingredient of our culture; but, insofar as they build "one world" while conserving the values of the small community, they are ensuring the revitalization and survival of civilization.

A similar analysis can be made of the complex interaction between other inventions and traditions. Equally important, for example, is the interplay between the relatively new techniques of industrialism and the rela-

tively old traditions of "rugged individualism" and "free enterprise." Karl Marx, Thorstein Veblen, Lewis Mumford, and others have analyzed the interaction of these factors; and they have revealed how complex and fecund is this interplay, involving the action and reaction, conflict and mutual transfiguration, of inventions and traditions. I have said enough, however, to emphasize that technology operates within a cultural context, that its potentialities are both destructive and constructive, and that it must be guided and controlled if its constructive development is greatly to outweigh and exceed its destructive tendency.

In view of the dynamic development of technology, it has been called "the blacksmith of civilization." We are now in a position to judge both the truth and falsity of this appellation. Technology implements each new civilization: by supplying the society with tools and energies, it establishes the limits of its potential achievement; and by challenging and disrupting traditions, it casts old forms of life, which are often a barrier to progress, upon the ash heap of obsolescence. However, at times its effect is to injure or retard. It may, for example, so swiftly and violently disrupt traditions that it fatally breaks the historical continuity of the civilization. Or, by supplying great power and efficiency, it may lend terrific drive to vicious traditions and aggressive intentions. Or it may so predominantly serve the rich and powerful that it tragically accentuates the chasm between the underprivileged and the overprivileged. Or it may become so refined and specialized that it ceases to minister to the fundamental needs of man.

Because it frequently does *not* promote the values of civilization, there is no necessary correlation between its growth and the growth of civilization. This generalization is confirmed by Arnold J. Toynbee in his erudite *A Study of History,* in which he examines the vicissitudes of twenty-one full-fledged civilizations and a number of "arrested" or "abortive" civilizations, including every great civilized society of which we have any sufficient historical record. Upon the basis of this survey, Toynbee comes to this conclusion:

> If we set ourselves to plot two sets of curves—one set representing the vicissitudes of civilizations and the other the vicissitudes of techniques—the two sets of curves not only fail to correspond but display wide discrepancies. We have found cases of techniques improving while civilizations remain static or decline and cases of techniques remaining static while civilizations are in movement, either forward or backward as the case may be.

It follows from this conclusion that technology *is* as technology *does.* It is a boon to mankind if it serves human interests; it is an abomination if it loses touch with these interests or serves the enemies of mankind. What, then, can guarantee its right use? Nothing but control by a democratic, inclusive, cooperative community. Technology cannot control itself: it cannot be controlled by the technicians: it cannot be successfully controlled by any limited or special group: it must, therefore, be controlled by the whole community through its representative agencies.

Some people, beguiled by the marvelous potentialities of applied science, have assumed that neotechniques will simply and automatically evolve into a vastly better world. This is a very plausible view because science *can* do wonders for man. There are great constructive potentialities, for example, in the development of electricity and electronics; in the use of the new alloys and light metals and synthetics; in the tapping of new sources of power, including atomic fission; in the invention of ever more automatic and fecund machinery; in the employment of radioactivity in medical therapy and radioactive "tracers" in medical research; and in the production of the sulfa drugs, penicillin, streptomycin, and other bactericides. When we consider such great scientific developments, we realize that science has given man the means to achieve a far healthier and happier existence. Since it is difficult to avoid wishful thinking, we are tempted to suppose that what *may* happen *will* happen. To be realistic, however, we must check ourselves: we must realize that a fascist government, or any gang of willful, selfish men, will misuse these

neotechniques as readily as they will misuse any techniques. Moreover, the new instruments and methods are as destructive as they are constructive: witness the atomic bomb! What is decisive is *who* controls technology and *for what ends*. Technology cannot control itself.

Nor can the technicians alone do the controlling. Nothing would seem more natural than to suppose that the proper people to control technology are the scientists and engineers who produce it. The popular reform movement that calls itself "technocracy" is based upon this assumption. But technicians cannot and should not control technology. They cannot because they are not powerful enough; they are not, and cannot be expected to be, dominant as a class. Indeed, they lack enough money of their own to supply their expensive laboratories and equipment, or to maintain themselves and their families while working on long projects. Therefore, they are dependent on those who control the purse strings and are necessarily the servants of the dominant class and the dominant ideologies. In one country, for example, they will work primarily in the interests of big business; in another country, they will fit into the designs of a socialist planning board; in still another country, they will work for the fascist war lords. Even if we could imagine social changes that would make the scientists and technicians dominant as a class, we still would have no good reason to say that they should control the applications of technology. As Aldous Huxley has reminded us in his brilliant satire, *This Brave New World,* the objectives of the experts may not be the humane and legitimate objectives of the community. An economic expert, for example, may conceive and plan an economically efficient society of willing, or perhaps even unwilling, slaves; or a military expert may turn the society into an armed camp. In general, scientists and technicians are men of a high degree of specialization, and consequently they often have a very limited grasp of social objectives. Moreover, as individuals who have benefited from a long and expensive education, they are usually drawn from the more privileged groups—privileged, at least, in comparison with the masses—and they often retain something of the class bias of their relatively fortunate status. If we are sincere democrats, moreover, we will reject the ideal of an oligarchy of technicians. We will prefer the ideal stated by David Lilienthal in his *TVA: Democracy on the March* that the experts should educate the people, so as to enlarge their political choices by revealing what alternatives technology makes possible; but that the people, in turn, should educate the technicians so as to make clear the wants and needs of the community and thus to define the great ends that technology should serve. In order to secure this process of mutual instruction, what is required is not an oligarchy of technicians, but a democracy that will bring the people and the experts together in beneficent interaction.

If the technicians acting alone are not fit to control technology, neither is any other limited group. We know the immense suffering that was the price of the old industrial revolution, and we know how frequently it deepened the chasm between the overprivileged and the underprivileged. Now we are in the dawn of a new technological and industrial revolution probably far greater than any in the past. We should resolve that this second revolution will not be bought at the terrible price of the first and will not be used to deepen the gulf between the many who toil without enjoying the fruits and the few who enjoy the fruits without toil. No private interest working for profit, no restricted gang scheming for power, can guarantee that this will not happen. An impressive body of evidence has been collected by governmental agencies such as the Federal Communications Commission, the National Resources Committee, and the Temporary National Economic Committee, and by individual social scientists such as Bernhard J. Stern and Wendell Berge, to show that private business and other special interest groups have in many instances thwarted science, opposed technological progress, and maintained their private "rights" above the interests of the community. We cannot, therefore, permit applied science—which can either destroy civilization or give it a new birth of freedom

—to fall under the control of a little grasping plutocracy, or a scheming military cabal, or an irresponsible political crew.

The only alternative that remains is to put technology under the control of the whole community operating through democratic processes. This community may be local, regional, national, or international—small or great—depending upon the scale of technological factors brought under control. Only such a community, organized justly and operating democratically, can serve the common cause and avoid partiality, segmentation, and conflict of interests. Only the community, representing the composite interests of all, can weave together the human, natural, and technological factors required for a balanced and economical development of resources. Only T.V.A., as a comprehensive democratic planning agency, for example, can achieve an integrated use of technicians, technologies, and machines, and land, minerals, waters, and forests in their interaction and interdependence and in their relation to the *people* of the Tennessee Valley. Only the whole community, acting through its responsible planning agencies, is great enough to perform the greatest tasks of technology, such as the development of water power and land reclamation throughout the great Columbia and Missouri valleys, or the full, constructive exploitation of atomic power. Nothing short of the whole community, operating through a National Research Foundation and kindred agencies, has the resources and interests adequately to support science and technology. Only the community, guided by an intelligent awareness of its own needs and interests, can weigh various technological factors, and emphasize some as more consonant with social welfare than others. Only such comprehensive social control, aiding and abetting the lagging factors in the culture, can hope to rectify the profound cultural disequilibrium that results from the relative underdevelopment of the humanities and social sciences in comparison with the immense development of the physical technologies and the natural sciences.

Admittedly, there are great difficulties in achieving a democratic control by the community of the rampant forces released by applied science. The toughest problem is the readjustment of the old institutions of private property and national sovereignty to the new factors of technology and industrialism. So long as irresponsible private wealth and the absolute nation-state are more powerful than the democratic community, the problem of achieving a humane control over technology cannot be solved. By means of social regulation or social ownership, therefore, the community must assert its supremacy over irresponsible private economic power, especially over vast cartels, monopolies, and billionaire corporations. By strengthening world government, the international community must achieve dominance over the irresponsible nation-state. We, the citizens, operating through the state and other civic agencies, should bring about these changes democratically and experimentally, adapting our policies to a host of concrete circumstances that we cannot foresee. The means must be flexible, but the ends must be clear and the determination unfaltering. If we do not act with resolution and dispatch, the alternative of war or revolution will eventually overwhelm us.

Is catastrophe inevitable? Some men believe so. "Optimism is cowardice," argued Spengler. The only allies of technology, he maintained, are imperialism and war. "Not so!" we whisper in our hearts. "Power is good if he who wields it is good." Technology gives us stupendous power either for good or ill. If for good, we must preserve and revitalize the small, intimate community, in which men learn the ways of human fellowship, and we must create the great community of all peoples, which will find institutional expression in a powerful world government. Only devotion to the community, small and great, can ensure survival. If we decide, instead, to continue the old game of reckless profit-seeking, urban concentration, power politics, imperialism, and selfish nationalism, our fate will be sealed. In the words of Thomas Hardy:

> No auguring mind can doubt that deeds which root
> In steadiest purpose only, will effect
> Deliverance from a world-calamity
> As dark as any in the vaults of Time.

LIFE'S GREATEST EVIL

ALEXANDER F. SKUTCH

Dr. Skutch took his doctorate in botany at Johns Hopkins in 1928 and spent the next two years in Panama and Honduras studying the anatomy of the banana leaf. At that time he became interested in the birds of Central America and resolved to make a study of them. This he did, combining his bird studies with plant collecting. Having, in the course of his travels, come to look upon Costa Rica's Valley of El General as his home, in 1941 he bought a farm of 50 hectares, newly carved from the forest. Here he has lived ever since, doing subsistence farming and devoting his spare time to the study of wild life and to writing.

DURING my senior year in college, I used to indulge in long philosophic discussions with a lower classman—now a distinguished professor, but then still in the overwise stage of early learning—who held that there is neither good nor evil in the world, but only survival and failure to survive. After long pondering, I believe that I can define good and evil in terms to which even a biologist of the mechanistic school can hardly take exception. At least, I fancy that I can do so for evil.

The great evil of life is parasitism. In the vegetable kingdom it is easy to recognize a parasite, a plant that does not manufacture its food directly from inorganic substances present in the soil, water, and air, but removes it from the tissues of other living plants, or even from animals. But when we turn from the vegetable to the animal kingdom, the definition of a parasite is not so simple. In the sense in which we apply the term to plants, all animals are parasites, for they must take their nourishment from other living things. For them we need another definition of parasitism, and it will be well if we can apply this definition also to parasitism among plants. For the purposes of this discussion, we may define a parasite as an organism that lives without making use of those faculties which are the peculiar characteristics of the class of organisms of which it is a member. The outstanding characteristic of plants as a whole—what sets them apart from other groups of living things—is their ability to build up organic compounds from inorganic substances, using for this purpose the energy of sunlight or, in rare instances, forms of chemical energy. Any plant lacking this faculty is by our definition parasitic, although I would exclude from this category the saprophytic fungi, which possess the peculiar faculty of breaking down dead organic substances and are, by virtue of this, most useful organisms, playing an indispensable part in the economy of nature. Mistletoes and other plants of similar habit are generally called half-parasites—a well-chosen term. They possess the faculty of photosynthesis, but lack another ability almost equally widespread in the vegetable kingdom, that of absorbing water and salts directly from the environment; rather, they take them from the tissues of some other living plant. Vines are another kind of partial parasite because they lack still another prime characteristic of vascular plants, that of holding their stems erect.

The peculiar faculties of animals are the directive senses and the power of locomotion. The host of flukes, tapeworms, cestodes, and other animals that live entirely within the bodies of bigger animals—unpigmented, sightless, deaf, practically devoid of the power of independent locomotion—are parasites in the highest degree. A tick that lives on the outside of its host is scarcely less a parasite; it merely sits down and sucks blood, has poorly developed sense organs, and only the weakest powers of locomotion. But a mosquito, which also gorges itself with our blood and is almost equally repugnant to us, is not a parasite. Its senses are acute, and it possesses a high degree of agility, as we soon learn when we try to swat one of our tormentors of this class—at least before it becomes bloated and heavy with blood. In its manner of life it is almost in the same class

with the bee, which sucks the juices of flowers rather than those of red-blooded animals. The shark, although a carnivore, is not a parasite; but the remora, which attaches itself to the shark and shares its food, is a parasite, because it has lost much of the faculty of swimming, a prime characteristic of fishes. Among birds, cowbirds, cuckoos, and other species that drop their eggs into the nests of other birds to be incubated by them are justly called parasites; although in their manner of flying, obtaining food, and the like they are normal birds, they have lost one of the primary avian faculties, that of building nests, with the subsequent hatching of eggs and attending the offspring.

Parasitism is an unmitigated evil—an evil that cuts two ways. It results in the degeneracy of the parasite; and in the host species it causes immense destruction while contributing little or nothing to the evolutionary development of that species—perhaps even causing retrogression if the parasitism is heavy. The degeneration of parasites, both structural and functional, is so obvious and has been so often discussed that here we need only to call attention to it. Compare any parasitic plant devoid of chlorophyll with any leafy green plant; a tick or other sessile bloodsucker with a spider or any flying insect; or, in the particular field in which it is parasitic, a cowbird or European cuckoo with any nest-building bird—the points of degeneration are obvious.

Turning now to the effects of the parasites on the species that serve as hosts, when we consider the countless numbers of individuals that through many generations have been attacked or killed by the parasites, I think it altogether marvelous that parasitism has had so little apparent evolutionary effect upon the hosts either in structure or in habits. Among plants, I am familiar with no important structural modifications that might with confidence be attributed to the selective influence of parasites. Perhaps some plants have developed heavier and denser bark, thicker and more impermeable cuticles, or increased lignification of internal tissues through the natural selection of individuals that, by these means, more successfully withstood the penetration of parasitic fungi. But these modifications of vegetable tissues appear to result from the influences of dryness, strong insolation, and other physical conditions of the environment rather than from the menace of parasites. At best, the modifications induced in plants by parasites are largely in the microscopic field rather than in gross structure.

Among animals, parasites appear to have had strangely little effect in modifying either structure or habits. When we reflect upon the countless millions of men who have succumbed to various widespread forms of disease caused by microscopic parasites—and some of larger size—it is unbelievable how little direct effect the incidence of these diseases has had on the dietary, sanitary, or other habits of mankind. I have heard it said that the widespread custom of tea-drinking in China arose out of the danger of drinking polluted water without boiling; and possibly religious injunctions against the consumption of pork were given as a preventive of tapeworm infection (although if this had been the real motive the danger could have been avoided by adequate cooking). But instances of this sort are uncommon, and at most they represent attempts to meet the menace of a pitifully small proportion of the parasites that from time immemorial have preyed upon mankind. It was only after scientific investigations—conducted largely within the past few generations—had shown us how by modifying our way of life we could avoid certain parasitic infections that the existence of these parasites caused any salutary change in our habits. In a restricted but fascinating field in which I am especially interested, I cannot discover that the parasitism of nests—extremely heavy in some species—by cuckoos, cowbirds, and their like has had any marked effect upon the nidification or other reproductive habits of their victims.

It is instructive to compare the evolutionary effects of the struggle between parasite and host with other forms of conflict in the living world: that between individuals of the same species or of species with similar habits,

and that between predator and prey. Quite in contrast with parasitism, these forms of competition have had immense effect upon the development of both plants and animals. The competition of green plant with green plant for a place in the sun has led to the progressive upward elongation and strengthening of stems; it is apparently to this struggle that we owe the loftiest trees and the most impressive forests. Yet the competition between self-supported green plants and even half-parasites like vines and creepers—a struggle keen enough throughout the humid tropics—has led to very little modification in the structure of the victims, save perhaps here and there a quickening of upward growth, a reduction of branching in early life, and greater smoothness of bark, which make it more difficult for vines to attach themselves to trees. The competition between vine and vine can lead only to a chaotic tangle of vegetation.

Among animals with kindred dietary habits, competition has led to a sharpening of sight, scent, and wits; an increase in swiftness, endurance, and radius of foraging; and, to take a single classic example of modification in structure, to the lengthening of the neck of the giraffe, which enables it to reach foliage beyond the grasp of other browsing animals. Even more important, perhaps, this competition has led to endless diversification and specialization, with correlated changes in structure and function. Thus the flycatcher, the wood warbler, the creeper, and the thrush are all insectivorous birds, but competition for this type of food has favored specialization, so that the first catches it in the air; the second, among the foliage; the third, on the bark of trees; and the last, largely on the ground—and each has peculiar structures and habits to fit it for the part it plays in the economy of nature.

Predation has also been of the greatest importance in shaping the course of the evolutionary development of living creatures. It seems likely that the predation—if we may use the term in this instance—of grazing animals upon herbage has led to the development, in grasses and plants associated with them, of basal or intercalary modes of growth, which enable these herbs to resist the effects of grazing far better than plants with the apical type of growth that is more common in the vegetable kingdom. Since grasses cover so large a proportion of the land areas of our planet, the importance of this modification in mode of growth in response to predation can hardly be exaggerated. Among animals, predation has led to greater keenness of senses and fleetness of movement in both the predators and the prey, and to many curious modifications in form and color which help the latter to elude the sharp eyes of their persecutors. Among mankind, a few real or quasi predators, such as tigers and venomous snakes, have far greater influence upon the manner of living and thinking of primitive people than the parasites that cause them infinitely more harm. Only as science helps us to evaluate the real magnitude of the dangers to be feared from the various classes of our enemies is this situation reversed. My rather primitive neighbors are far more afraid of the *tigre* than I; I fear a host of invisible organisms they never think about.

We may lament the tremendous loss of life, even up to the extermination of whole species, brought about by the competition between individual and individual in a crowded world, and by the habit of one living thing preying upon another. But at least this competition and this predation have been fruitful in the progressive development of organisms in myriad diverse ways. Parasitism has taken its tremendous toll of life with scarcely any return that we can see; it has led to retrogression rather than to progress. Hence, we may call it the greatest evil of life.

The opposite effects on living things of parasitism on the one hand and predation and competition on the other are not far to seek. Modifications brought about in a species through the selective actions of the latter are of general value and usually result in the greater fitness of the organism to meet the varied stresses of its environment. The length of trunk that enables the jacaranda tree to hold its crown above that of the ira also serves to hold it above that of the campana and most others of its competitors in the tropical forest. The thorns that protect a bush from browsing by a cow usually also serve to guard it against the horse, the ass,

and the deer. The fleetness that enables the antelope to outrun the lion will serve it in good stead when pursued by the tiger, the panther, and the wolf. The intelligence of the crow helps it not only in its quest of food, but also in outwitting its archenemy, man.

But the heritable modifications brought about in organisms through the selective action of parasites are as a rule neither in structure nor in habits, but only in the form of slight modifications in chemical composition, and these modifications are rarely of general value. A man may become immune to typhoid fever without acquiring immunity to lockjaw, although the bacteria causing these two diseases are so similar in appearance that they are classified in the same genus. Indeed, an individual may be resistant to one strain of a pathogene and susceptible to another; and it seems that some of the fungi and bacteria that cause disease may be constantly changing, either by selection or through mutation, so that they repeatedly overcome any resistance their victims might have acquired to them in their earlier forms. Such insidious, protean adversaries can have little effect in developing the species they parasitize; they serve only to destroy.

AMONG men the greatest evil is the same as that in organic nature as a whole—parasitism. In order to apply to mankind our definition of a parasite as "an organism that lives without making use of those faculties which are the peculiar characteristics of the class of organisms of which it is a member," we must first decide what are the peculiar, distinguishing characteristics of the human species. Considering chiefly the means by which each group of organisms maintains life, the peculiar faculty of men is their ability to produce what they need by mental or physical effort or, more usually, by a well-balanced combination of the two. This ability distinguishes all but the lowest savages among men from all other mammals except, to a certain extent, the beaver, and from all animals of other classes except a few of the social insects, notable among which are the agricultural atta ants.

The parasites among men are those who exist through the efforts of other men, producing nothing themselves. They include the idle rich who live in sloth on inherited fortunes, the shiftless poor who live on charity or such windfalls as they can find, the thief, the swindler, the forger, the smuggler, and the panderer to the vices and follies of men. The highwayman, were he a member of the feline or the canine tribe, would not be classed as a parasite but as a predatory animal—although predatory animals do not as a rule prey upon others of their own species. He has often developed to a high degree the keenness of sense, the speed, the endurance, and the cunning of a predator; but he has not developed the peculiarly human faculty of productive physical or intellectual activity, and as a man we must class him as a parasite.

The losses to mankind by human parasites, their continued drain on human effort through the ages, have been incalculably great. In aggregate they have probably been responsible for a wastage of human effort of the same order of magnitude as that caused by wars. The total becomes far more stupendous if we include in the category of parasitism all those wars which were essentially parasitic in nature. From the raids of wild clans to carry off cattle, grain, or other coveted goods from their neighbors, through the strife of medieval barons and princelings who coveted their neighbors' estates, down to World War II—which began as a gigantic attempt by the mad, unprincipled leaders of a fanatical political party to enrich themselves at the expense of all the world—a large proportion of all wars have been for the purpose of plundering, and hence parasitic in character.

Despite this vast and continued wastage, it is amazing how little effect parasitism has had upon the essential structure of human society. This statement may at first glimpse appear extravagant. To test the effects parasites might have had upon the character of human institutions, let us imagine what would be the results of their complete removal. Could we somehow get rid of all thieves, swindlers, counterfeiters, forgers, and idlers, poor and rich, in what way would our customs and manner of life change? Surprisingly little, I believe. We should have fewer

locks on our doors; but only an infinitesimal portion of human ingenuity has been devoted to the devising of locks and safes. There would be fewer policemen in the streets and a slightly lower tax rate, because we would not be obliged to support a large force for law enforcement nor institutions for the confinement of thieves and their like. We would be less careful in examining the signatures on our checks and other documents. We should be less preoccupied over the safety of our property, but otherwise we should go on living much as we have lived. The constant drain on human wealth and effort through the activities of human parasites has influenced our way of life as amazingly little as the unending menace to human life and health by smaller parasites has altered our pattern of living.

Again, it is instructive to compare the effects of parasitism with those of competition within the species. Honest and legitimate competition in business or other fields of human endeavor has ruined the hopes and blighted the lives of the countless men who have lost out in it, and caused unmeasured misery and suffering to them and their dependents—possibly as much as the loss of possessions through dishonest activities. The latter has been an unmitigated evil, whereas the former has had many favorable consequences for society as a whole. A manufacturer who by fair means drives his competitors into bankruptcy or puts them out of business must either make a better product, or the same product by a more efficient process, so that he can sell it at a lower price. Driven by the pressure to improve their methods of manufacture or starve, other producers of the same article will perfect their operations, and eventually the whole community will benefit through having cheaper and better wares. Competition is cruel but productive; parasitism, cruel and nonproductive.

Among men, as among all other organisms, parasitism is the absolute and unmixed evil—the evil that cuts two ways. For the parasite it results in moral and often, too, in intellectual and physical degeneration; for the hosts—the rest of society—it causes tremendous losses with no compensating gains.

SEND THE SM TO VETERANS' HOSPITALS

Having reason to believe that patients in Veterans' hospitals want to read scientific as well as popular magazines, the Engineers' Society of Milwaukee has appealed for contributions of technical journals to the local hospital. As the response was gratifying, Samuel R. Snead, of that Society, suggests that the appeal be made on a national basis. Specifically, we suggest that unneeded copies of the SM be sent to the nearest Veterans' hospital. The SM has the desired meat in it, without being terrifyingly technical.—Ed.

SCIENCE ON THE MARCH

METEORITES: COMET COMPONENTS

IN THESE boom days of science, we are inclined to look with condescension upon the ignorance and superstition of our forebears. Among the most persistent of these superstitions have been those of astronomical origin, and no celestial phenomena have spread more general terror than the unheralded appearances of spectacular comets. The long and impressive list of evils attributed to these visitors includes droughts, plagues, pestilence, and even the loss of the Battle of Hastings. Evidently, disasters of one sort or another have been so prevalent that a current misfortune has always been conveniently available to blame on any hapless comet.

The appearance of a great comet is still an awesome but no longer a fearful sight. Thanks to such men as Newton and Halley, it is known that comets are not capricious in their movements but are obedient to the same laws of motion as are the planets. Progress toward an understanding of the nature and origin of comets, however, has been slow. Although comets may rival the sun in size and possess tails as long as the diameter of the earth's orbit, their masses are so small as to defy any direct measurement. When Halley's Comet paid its last visit in 1909–10, it passed directly between us and the sun. Projected against the sun's disk, it was completely invisible, although, had a solid object 50 kilometers in diameter existed in its head, this should have been detectable with powerful telescopes. In 1927, when Comet Pons-Winnecke passed unusually close to the earth, its nucleus was subjected to the most careful telescopic scrutiny under conditions which precluded the possibility of its containing solid pieces larger than one or two kilometers in diameter. In short, direct telescopic observation gives no evidence of any solid matter in comets.

Our ignorance concerning the origin and age of comets is even more complete. No one knows whether comets are coeval with the solar system or whether they are relatively recent additions of local or interstellar origin. We may well wonder whether such nebulous objects as comets can be expected to have maintained their identity during the several billion years that the solar system has existed. The study of meteors and meteorites has provided, and may continue to provide, clues to the solution of these cometary enigmas.

The revelation that a meteor shower may be produced by a collision of the earth with a swarm of solid particles moving along the orbit of a known or defunct comet was one of the greatest astronomical discoveries of the nineteenth century. It was in 1866 that the Italian astronomer Schiaparelli noted that the swarm of meteorites responsible for the annual Perseid shower was moving about the sun in an orbit almost identical with that of Comet 1862 III. In 1940, Whipple, of Harvard, brought the definite associations up to nine by relating the Taurid shower to Enke's Comet. But the discoveries still continue, and in 1946 a shower was observed in Europe that is probably related to Tuttle's Comet.

There is little doubt that the particles producing these meteor showers originate in the comets. Where a short-period comet is still sufficiently intact to be seen, the particles are usually strongly concentrated along the orbit only in the vicinity of the comet. The closer the earth is to the comet when it intersects the comet's orbit, the more intense the resulting meteor shower is likely to be. It should be emphasized that all meteor showers have not been associated with comets; neither are all comets known to produce meteor showers. Long-period comets return to the sun so infrequently that their gravitational bonds appear not yet to have been loosened by the tidal action of the sun and planets, and no debris has been found in the wake of such an object.

Careful studies of these meteor showers are

revealing much valuable information concerning the nature and distribution of solid matter in comets. In the case of the Perseids, where material is rather uniformly distributed along the orbit, the mass of the comet, before disintegration began, can be estimated. The swarm consists of particles a few milligrams in mass separated, on the average, by distances of over 100 miles. A knowledge of the size of the orbit leads to a figure of 500 million tons for the lower limit of the mass of the comet. Since the particles in a swarm are all moving at about the same velocity in space, the meteors that they produce on plunging into the atmosphere are proportional in brightness to the masses of the particles. In the seemingly old Perseid, Leonid, and Geminid showers, faint meteors are rare, and fireballs are also very infrequent. Showers from the debris of relatively young comets, such as Comet Giacobini-Zinner, show, on the contrary, a wide range in particle size: 1,000 to 1 range in mass, with the small particles the more numerous. Observational data obtained from the shower of October 9, 1946, by La Paz at the Institute of Meteoritics of the University of New Mexico show not only that the particles trailing Comet Giacobini-Zinner are subject to considerable variation in size, but also that they exhibit a pronounced tendency toward clustering. The theory of relativity predicts a gradual segregation of the particles of a swarm into different orbits according to size (the Poynting-Robertson Effect). This circumstance is disappointing, as it indicates that the present population of a swarm may not reliably indicate the size of the largest particles originally in the comet. This segregation may be responsible in part for the fact that no meteorite from a shower has ever been known to reach the earth's surface. Those particles that were large enough to weather passage through the earth's atmosphere, if they ever existed in the swarms, are apparently no longer in them.

The complete lack of evidence that a meteorite from a shower has ever reached the earth's surface is of itself sufficient reason for questioning the similarity between the particles causing shower meteors and those causing meteors of the sporadic variety. There are excellent additional reasons. Fallen meteorites may be roughly classified as either irons or stones, and the spectra of sporadic meteors are found to be of two types quite compatible with the observed composition of the fallen meteorites. All spectra of shower meteors, on the other hand, indicate that the shower particles are stones. Sporadic meteors appear rather consistently at a height of 95 kilometers, whereas shower meteors that the earth strikes head-on appear at about 115 kilometers. Part of this difference can be attributed to the difference in velocity, but it seems necessary to postulate also a difference in constitution.

Precise data bearing on the friability of cometary meteorites were obtained by La Paz at the Institute of Meteoritics for the 1946 Giacobinid shower. Photographs of the shower were taken from the ground by the use of K-24 aerial reconnaissance cameras. Through the courtesy of the Army Air Forces, additional photographs were obtained from a B-29 flying above 20,000 feet. A bright fireball was photographed from the air. The photograph shows clearly that there were two flashes of light from the fireball before it disappeared. More precise pictures of the light variations along the paths of meteors were obtained by running microdensitometer tracings of the photographed trails. A photograph of the light curve of a bright Giacobinid meteor indicates that for this meteor there is evidence also of a double maximum. This was probably the result of a fracturing of the meteorite under the stress of the air through which it was rushing.

These evidences of differences between shower and sporadic meteors give rise to several fundamental questions: Why are they different? What is the ratio of shower to sporadic meteors? If the sporadic meteors are not of cometary origin, whence did they come? Clues to the solutions of these problems are to be found in a relatively new branch of meteor research that began with the application of photography to the study of meteor velocities. Harvard has pioneered in this work and, since 1936, has had a synchronized observing program in operation at

Cambridge and at Oak Ridge, Massachusetts. Cameras at both stations are directed toward common points about 80 kilometers above the earth. During exposures, rotating shutters occult the camera lenses twenty times a second. When a meteor is photographed simultaneously at both stations, its points of appearance and disappearance in the atmosphere and its velocity become calculable with considerable precision. The probable error of the velocity is of the order of 1 percent. Some 1,400 meteors have been recorded on Harvard plates, and at least 1,000 of these meteors have left measurable trails. At present, a meteor must rival a bright star in luminosity in order to record itself on a plate, but faster plates and cameras will make possible the extension of the work to fainter objects.

The British have carried out some successful meteor experiments with radar and have measured the velocities of some twenty invading meteorites by this method. In some cases, the reduction of velocity, owing to the retardation of the atmosphere, has been measurable.

The accurate determination of velocities that photography makes possible is of great importance in the study of the origin of meteorites. The rate of speed with which a meteorite enters our atmosphere identifies it as either a regular member of the solar system or a visitor from interstellar space. If the meteorite is exceeding the speed limit, so to speak, its path with respect to the sun is hyperbolic. If its velocity is below the critical value, its orbit is elliptical. Investigation points strongly to the fact that inexperienced observers tend, in estimating the point of appearance of a meteor, to extrapolate backward too far along the path. This procedure makes the corresponding velocity estimate too high and leads to too many hyperbolic velocities. In the fireball catalog of Von Niessel and Hoffmeister, 80 percent of the meteor velocities are listed as exceeding the parabolic limit. In 1931, Harvard and Cornell cooperated in a meteor expedition to Arizona, in an effort to accumulate accurate data based on the observations of experts. The results of the expedition, obtained visually, indicated that 66 percent of the sporadic meteors had hyperbolic velocities. Evidence of systematic errors, however, has been found in the data. The most significant information on meteor speeds is that, to date, no meteor that has been simultaneously photographed from Harvard's two stations has had a definitely hyperbolic orbit; in fact, none has had even a questionably hyperbolic orbit. In time, the photographic method may show that few if any meteors are produced by meteorites that are not regular members of the solar family.

At present, the ratio of shower to sporadic meteors appears to be at least one-half, and as additional data are obtained the fraction is increasing. It is currently estimated that three-fourths of the meteors observed from northern stations between August 2 and 22 each year are members of the Perseid shower. Hoffmeister reports evidence of meteor showers from meteorite streams moving in orbits of a planetary character with low inclination and small eccentricity. Some of these ecliptic currents, as Hoffmeister terms them, are very roughly defined and cause showers over periods approaching three months in length. He makes the interesting observation also that if the orbits of the Piscids, the Scorpio-Sagittarids, and the Virginids were each turned through 22° of longitude, they would closely coincide with the orbits of the minor planets Hermes, Adonis, and Apollo. Differences of the sort already mentioned between shower and sporadic meteors appear to exist between meteors from cometary currents and those from ecliptic currents. The meteorites have a different mass-frequency function, and the material in the ecliptic currents is more "consistent" than that in cometary currents. According to Hoffmeister, 68 percent of the cometary meteors brighter than magnitude 3.5 have trains, whereas only 18 percent of the meteors within the same brightness range from ecliptic currents exhibit trains.

Whipple, of Harvard, has independently discovered that all shower orbits are not typically cometary in character. From simultaneous photographs of five Geminid meteors he has calculated five reliable sets of orbital

elements. On the average, the periods are only 1.65 years, and, when closest to the sun, the meteorites are within 13.9 percent of the earth's average distance from the sun. Their orbits are inclined 23.5° to that of the earth, and they have an eccentricity of 0.900. Such orbits are unique among those of both comets and minor planets.

If the fragments producing the Geminid shower were all moving in the same, or parallel, paths, all Geminid meteors would seem to emanate from a single radiant point in the sky, which would be the point of convergence of their apparent paths extended backward. Whipple's precise observations unquestionably indicate small variations of the radiant point, and hence of the elements of the orbits themselves. He is confident that the Geminid meteorites were once incorporated in the main body of a comet, and he favors the explanation that the present deviations from the mean orbit are the result of perturbations caused by the planets, particularly Jupiter, subsequent to some initial disruptive action. Whipple states, in addition, that a suitable theory of perturbations for the Geminid swarm should yield some measure of the age of the swarm—in other words, the length of time required to produce the present deviations from a mean orbit.

The application of precision methods to the study of the motions of meteors is still in its infancy, but the infant is a sturdy and promising one, and meteoriticists hopefully predict for it a brilliant future.

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ITINERARY*

FIRST ANNUAL INTERNATIONAL PHOTOGRAPHY-IN-SCIENCE SALON

GAMMA SIGMA EPSILON University of Florida Gainesville	May 13–June 1
THE JOHN CRERAR LIBRARY Chicago, Illinois	June 8–June 21
AUBURN CAMERA CLUB Bureau of Animal Industry U.S.D.A. Auburn, Alabama	June 28–July 12
AMERICAN OSTEOPATHIC ASSOCIATION ANNUAL CONVENTION Boston, Massachusetts	July 19–23
ACADEMY OF SCIENCE Illinois Wesleyan University Bloomington	Otober 1–15

* Dates available for showing both 1947 and 1948 Salon pictures.

BOOK REVIEWS

WHEN DOCTORS DISAGREE

Private Enterprise or Government in Medicine. Louis Hopewell Bauer. ix + 201 pp. $5.00. Charles C Thomas, Publisher. Springfield, Ill. 1947.

DR. BAUER, a member of the Board of Trustees of the American Medical Association and president of the Medical Society of the State of New York, is well qualified to present the official attitudes of organized medicine on the problem of more adequate distribution of medical services. I had hoped for something different after reading in Dr. Bauer's Preface that "the public, which, eventually, must decide the question, has not been given all the facts. The public wants to know both sides of the question." Unfortunately, the book presents only the well-known arguments promulgated by official spokesmen in support of the *status quo* in medicine.

The author devotes considerable space to the thesis that comprehensive Federal medical legislation such as the Wagner-Murray-Dingell Bill would "socialize" medicine. He overlooks the prime purpose of such legislation, which is to guarantee all our citizens preventive, diagnostic, and therapeutic medical services, independent of the vagaries of the economic cycle. Surely such a purpose is completely consistent with the highest ideals of our democracy.

Dr. Bauer gives the impression that only the low-income groups require financial assistance for medical services. Anyone who holds a contrary view he dismisses as a misguided left-winger. It is interesting that on March 8, 1948, the *New York Times* stated editorially:

> In the complex problem of providing medical care, one fact stands out clearly. The average person in the middle-income brackets simply cannot afford the mounting costs of first-rate medical care without some financial assistance or prepayment insurance.

The author is so preoccupied with fears about a future when the Public Health Service or other Federal agencies may supervise medical care that he completely fails to inform the reader how private enterprise can solve the following vital problems in medicine today:

1. The by-passing of the general practitioner by technical advances in medicine.
2. The place of group medical practice.
3. The salvage of rural medical practice, which has deteriorated alarmingly.
4. Adequate geographic planning of our national health facilities at a time when complex radioactive materials are required in diagnosis and therapy.
5. The inadequate education provided by 50 percent of our medical schools.

This list does not exhaust the many vital problems passed over by Dr. Bauer.

BENJAMIN F. MILLER

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STRANGE DEVICES

What Electronics Does. Vin Zeluff and John Markus. vii + 306 pp. Illus. $3.00. McGraw-Hill. New York. 1948.

THE associate editors of *Electronics* find in devices using electron tubes "a collection of engineering dreams come true and the Prince Charmings of electronics . . . happily married into the kingdoms of industry with every assurance of happiness ever after."

In concise accounts of some 400 applications and in 114 drawings and photographs, the authors emphasize the versatility of electronic devices and their uncanny ability to combine with ordinary instruments or machines to do jobs heretofore considered impossible. Time, weight, length, temperature, humidity, density, strain, viscosity, color, brightness, and many other variables can be measured by an electronic device of one sort or another, and the measurement can be translated into control.

There is little discussion of the limitations, economic or otherwise, of electronic devices. The physical principles on which they oper-

ate are discussed only incidentally, though accurately.

The numerous applications of electronics are presented, with some duplications, in 19 chapters bearing such titles as: In the Air, Afloat, Metals, Fighting, and Doctoring.

The general reader who wants to know what electronics can do for him will find in the lively descriptions of actual devices much up-to-date interesting information, and perhaps a stimulus for thinking of still newer techniques or better ways of doing old jobs. This book should be popular in school libraries.

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A SURGEON'S LIFE

George Crile, an Autobiography. Grace Crile, Ed. 2 vols. 624 pp. Illus. $10.00. Lippincott. Philadelphia and New York. 1947.

THIS "autobiography" is unique in that it was largely written in the form of notes and papers by Dr. Crile as his medical life unfolded and progressed. In the words of his wife,

> He knew that I was interested in his early beginnings and in all that came into his professional life, and since writing was his avocation, his satchel and pockets upon his return from out of town became for me a treasure store of autobiographical and wayside notes, amusing incidents and stories, dreams and plans for research and professional organization, and philosophical musing—all of which, for him had served their purpose since through writing he got them "out of his system" and, for me, they found their place in my files of his manuscripts and diaries.

These, religiously collected and carefully preserved by an adoring wife who felt that destiny had placed her husband in this world for outstanding achievements, reached the staggering total of more than 17,000 pages of manuscripts, a similar number of pages of diary, 38 additional volumes of war diaries, and 11 volumes of reprints.

From this mass of "autobiographical agenda" his wife, Grace Crile, who shared in a unique way in her husband's clinical, financial, and research activities and aspirations, has selected and edited the data which would in her opinion best depict the life and accomplishments of one of the great surgeons of a time when surgery was making some of its most outstanding advances.

Although the two volumes undoubtedly bear the imprint of the editor and reflect what she considers the more important parts of this mass of autobiographical material, additional interesting data from the point of view of the wife are given in the seven "side lights" written by her.

With this background and source of information, these two volumes of more than 600 pages lead one through Crile's early life and struggles, his successes, marriage, clinical and research activities, and down through the last years of failing health but years of intense activity and plans for the future.

Insight into the character of the man is given by the many references to strictly personal affairs, and his professional advancement is recorded in the development of a large practice with a group of lifetime associates, the rise to an important professorship in surgery, the experiences in two wars, many activities in the surgical world, and the establishment of the Cleveland Clinic Foundation.

A great deal of space is given to the development and progress of various research projects, particularly in regard to shock, control of blood pressure, hemorrhage and transfusions, effects of fear and pain, and the use of nitrous oxide anesthesia. As a result of these researches and observations, and certain deaths in toxic thyroid patients, he developed the idea of "stealing the thyroid gland." Later, in order "to prevent the discharge of nervous energy which would otherwise be caused by trauma," he blocked off the operative field with local anesthesia. In order to express this concept, the word "anoci-association" or "anociation," as later contracted, was coined.

Differences in electrical potential as an explanation of shock, and the development of the bipolar theory of life are described. There are many details of the hunting trips ranging from Florida to Africa, which he made to perform dissections on a great variety of animals differing widely in size and activity, in order to compare the relative

sizes of the brains, hearts, thyroids, and adrenals, and the complexity of the sympathetic nervous systems, in an attempt to throw some light on certain human behaviors and diseases.

Even though his contemporaries placed different values and interpretations on these researches, and surgical advances and future developments may further alter their significance, their presentation here adds much interest to the life history of a great surgeon.

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HIGH AND GHOSTLY MATTER

Telepathy and Medical Psychology. Jan Ehrenwald. 212 pp. $3.00. Norton. New York. 1948.

FREUD reported that he encountered telepathy in his psychoanalytic practice. Stekel wrote a book on telepathic dreams. Jung has long taken a reserved interest in parapsychological matters. Janet found what appears to have been telepathy early in his career, but did not follow it up. Among British psychiatrists, Mitchell, McDougall, and William Brown were frankly interested in the subject. Thus telepathy has been no stranger to medical psychology: nevertheless, Dr. Ehrenwald's book is the first full-length work on telepathy brought out in America by a medical man.

Dr. Ehrenwald is a New York neuropsychiatrist, formerly of the Universities of Prague and Vienna. He is a Fellow of the Royal Society of Medicine in England and is now associated with the Long Island College of Medicine.

As a psychiatrist Dr. Ehrenwald was less impressed by "the imposing array of statistical data furnished by laboratory experts" than by the "evidence of telepathy occurrences which can be observed in everyday life, in dreams, in the psychoanalytic situation, in neuroses and psychoses, if only we are prepared to meet them with an open mind." Our reluctance to do so is itself a "psychological symptom calling for inquiry."

The book deals first with telepathy in the relatively normal case, with telepathic dreams, and with the telepathic experiences often encountered in psychoanalysis and in trance states connected with mediumship. Next is a section on telepathy in psychotic patients, especially in cases of paranoia and schizophrenia. Dr. Ehrenwald concludes that telepathic research throws fresh light on the clinical picture and may have consequences for therapy itself. Finally, he offers detailed psychological analyses of two famous telepathic subjects and from the analyses draws implications for personality and personal relations. The book ends with a moderate and balanced comment on the significance of telepathy for better social organization.

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THE GRINDERS CEASE BECAUSE THEY ARE FEW

Your Teeth and How to Keep Them. Jerome J. Miller. ix + 232 pp. Illus. $3.00. Lantern Press. New York. 1947.

DENTISTRY is one of the most misunderstood of the sciences with which the general public comes in frequent contact. The average person has little or no idea of what is being done in his mouth, and the dentist seldom has the time to go into detail about his work. Miller's book does this task for the dentist in an admirable fashion. It begins with a description of the dental apparatus and its relationship to the general health, and proceeds to evaluations of the techniques of full and partial restorations of teeth. Between these extremes, Dr. Miller deals with children's dentistry, orthodontia, tooth-filling materials and their relative merits, mouth infections, wisdom teeth, and a factual discussion of the value of dentifrices and the ballyhoo that goes with them.

This book is a must for the person who is really interested in his teeth and who wants to know the how and why of his dentistry rather than remain in ignorance of facts so vital to his welfare.

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WHAT TO DO ABOUT BACKACHE

The Back and Its Disorders. Philip Lewin. xii + 157 pp. Illus. $2.50. Whittlesey House. New York. 1948.

DR. PHILIP LEWIN is a well-known and well-qualified orthopedic surgeon practicing in Chicago. He has written many books and articles on orthopedic subjects, among them a textbook for nurses on orthopedics, which is most valuable; and an outstanding textbook for orthopedic surgeons: *Backache and Sciatic Neuritis.* Besides being able to write often, long, and well, he has a busy practice; and he spent four years, though not a young man, serving his country as a colonel in charge of a large orthopedic service in an Army general hospital during World War II.

In *The Back and Its Disorders,* Dr. Lewin explains concisely, for the nonprofessional person, the major causes of back pain. The word "orthopedics" is derived from the Greek meaning "straight child." The practice of orthopedic surgery involves the care of the bones and joints, their muscles, nerves, ligaments, and blood vessels. Backache is, therefore, primarily a problem for the orthopedic surgeon. Such a surgeon must have, as a sufficient background of knowledge, not only high-school and college education, but four years of medical school, followed by five years of hospital training under qualified surgeons and two years of practice under supervision. After that he must pass the American Orthopedic Board examination. Dr. Lewin has reached a stage in life where he can be an examiner for the American Boards. He knows whereof he writes as he tells you and me in clear and simple language, free from tough medical terms, about the back and its disorders.

There is no one living who does not suffer from a backache at some time. Dr. Lewin has pointed out many causes of this in his book and has alluded to many others. He has explained the more common causes in language anyone can understand. The difficulty in reaching an active diagnosis—its why and wherefore—is described, and the methods by which a physician must reach his conclusion are given. There was a time, not many years ago, when the catchword "sacroiliac strain" was the answer to most backaches from both a lay and a professional standpoint. Newer knowledge, acquired through years of research, has put that term in its rare and rightful place. Because of this same newer knowledge of the back and its diseases, Dr. Lewin's book, written for the consumption of the general public, is very necessary. To find such an authoritative, enjoyable, and readable short book as this, about our own medical problems, is an unusual treat in the literature of today. May I suggest it as a must to physicians, medical students, nurses, and to you: the reading public?

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COSMIC DISTURBANCES*

Causes of Catastrophe. L. Don Leet. vii + 232 pp. Illus. $3.50. Whittlesey House. New York. 1948.

DR. LEET has written an urbane, instructive, entertaining, though somewhat uneven, discussion of some of nature's more violent manifestations. The forms of catastrophe examined are listed in a subtitle as Earthquakes, Volcanoes, Tidal Waves, and Hurricanes. Written for the general reader, the book presents effective descriptions of famous catastrophes; describes most of the important characteristics of earthquakes, volcanoes and their eruptions, tidal waves, and hurricanes; and discusses fundamental principles as well as proximate and ultimate causes.

The treatment of earthquakes is distinctly more comprehensive, more authoritative, and consequently more successful than that of the other topics. This is to be expected, as Dr. Leet's practicing field is seismology, in which he is a recognized leader. Since most catastrophic tidal waves (tsunami) are of seismic origin, it is surprising that the author gives them but a few pages. He fails even to mention an outstanding fact about them—namely, that major displacements of the sea

* Published by permission of the director, U. S. Geological Survey.

bottom in shallow water can produce great tsunami on near-by coasts but create no destructive waves on distant ones (*p.e.*, the eruption of Krakatoa Volcano in 1883), whereas comparatively minor displacements in deep water can produce cataclysmic tsunami thousands of miles away (*p.e.*, the Aleutian submarine quake and accompanying tsunami of April 1, 1946, which did extensive damage in Hawaii).

Dr. Leet does a valuable service in dispelling many myths connected with earthquakes. He effectively closes the "yawning chasms," disgorges the engulfed buildings and livestock, and modifies the "earthquake weather" of the imaginative but uninformed. At the same time, he warns that all the destructive earthquakes are not in the past and pleads for civic "catastrophe planning."

Popular misunderstandings regarding other forms of catastrophe are not as thoroughly resolved. In particular, Dr. Leet would have done well to extinguish the fire that is so persistently and incorrectly connected, in most minds, with volcanoes. The black clouds and fiery glow common to eruptions and the burnt appearance of some volcanic products make it easy to imagine that combustion is important in eruptions. Actually, the clouds are not smoke but rock debris and the glow is from molten, incandescent but not burning, lava. A little true burning doubtless results when certain uncommon volcanic gases, such as hydrogen, meet the air, but combustion definitely has only a bit part in the volcanic drama.

The book is abundantly illustrated, but suffers from poor integration of text and illustrations. All the illustrations lack numbers, and the sixteen pages of half tones even lack page numbers; many illustrations are far from their text references, with few clues to help the laboring reader find them.

In the otherwise well-organized text, the sections headed Modern Trails Across the Pacific (including a long discussion of time zones) and War-Name Islands seem irrelevant.

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GENIUS DOES WHAT IT MUST

The Gifted Child Grows Up. Lewis M. Terman, Melita H. Oden, and Associates. xiv + 448 pp. $6.00. Stanford Univ. Press. Stanford, Calif. 1947.

WHAT are the physical, mental, and personality traits of intellectually gifted children (i.e., those who score well within the upper 1 percent of American school children on intelligence tests), and what sort of adult does the typical gifted child become? More than a quarter of a century ago Professor Terman inaugurated a systematic study of this problem. The design of the investigation included the identification of some 1,500 children within the I.Q. range 135–200 in the California public-school population, intensive study of the characteristics of the subjects and their families, periodic follow-ups of the subjects through their adult years, and study of their progeny for several generations. This study has become a classic in the field of educational psychology.

The book under review here is the third published report on the gifted group. It is concerned primarily with a portrayal of the subjects twenty to twenty-five years after their original identification in 1921–22. Detailed descriptive data are presented concerning the mortality, physical and mental health, intellectual, educational, occupational, and economic status, avocational and other interests, political and social attitudes, marital status and adjustment, and war records of the subjects. Individual chapters are devoted to analyses of subjects of I.Q. 170 and above, subjects of Jewish descent, and subjects of high and low attainment. The discussion is enriched throughout by excerpts from individual case studies and by the authors' interpretation of the data.

What, specifically, does the study reveal about the gifted subjects who are now approaching middle adulthood? In the main, the findings are consistent with expectations aroused by previous study of the group. In terms of averages, the subjects continue to maintain their high intellectual status, are predominantly college-educated, enter the professional and higher business occupations,

and are headed toward the higher income brackets. In physical and mental health, personality characteristics, and marital and sexual adjustments, the subjects tend to be slightly superior to the general population.

Not all the subjects, however, conform to the typical pattern. Some appear to have undergone considerable regression in mental ability; they range in vocational success "all of the way from international eminence to semi-skilled labor"; a number were dropped from college on account of poor scholarship; and a large proportion of the successful college students made mediocre academic records. Thus it is clear, as the authors point out, that "intellect and achievement are far from perfectly correlated." The gifted may fail; a high I.Q. by no means assures successful achievement.

The present reviewer agrees in general with the authors' conclusion that, considering the limited funds available and the condition of psychological methodology at various stages of the research, there is "little to regret" regarding the choice of techniques employed in the investigation. Some critical comment, however, is in order.

On the technical side, it is regrettable that the authors depended upon an exclusively verbal and linguistic test (the Concept Mastery test) to estimate the psychometric intelligence of the subjects. The administration of a more comprehensive test measuring additional mental factors would have allowed a greater measure of confidence in some of the conclusions reached.

On the interpretational side, remarkably little attention is given to the hypothesis that adult attainment may be related to the socioeconomic and educational level of the parents. A suggestion lies in several of the relationships presented that these factors may be crucial determinants of adult achievement.

The study provides an excellent illustration of some of the difficulties inherent in psychological research of this nature. We have here a group for which the primary selective factor was a high I.Q., but which is also characterized by high socioeconomic status, uniformity in state of residence, and predominantly urban residence. Consequently, in the absence of adequate controls, what is attributed to high I.Q. may be due, in part at least, to one or more of the other factors. Further, the very fact of being included in a study produces changes in the behavior of the subjects. In the present instance, membership in Terman's group must surely have affected the level of aspiration of many subjects as well as have provided unusual opportunities for scholarship aid and employment. In the light of these considerations, generalizations based on the present study must be made with considerable caution.

Despite these fundamental limitations, the California study of the gifted is an extremely significant one. Its contributions to psychology have been many, including stimulation of the study of deviates, demonstration of the value of the genetic method, and the development of a number of psychometric devices. Educationally, the study has been of inestimable value, for it has been primarily responsible for bringing American schools to an understanding of the needs of exceptional children.

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PRECIS FOR LAYMEN

Energy Unlimited: The Electron and Atom in Everyday Life. Harry M. Davis. xiv + 273 pp. Illus. $4.00. Murray Hill Books. New York. 1947.

TAKING advantage of his many on-the-scene contacts with scientists and their laboratories, the author describes and interprets many recent discoveries and inventions in nuclear physics and electronics with numerous applications of today and some possible applications of tomorrow. The book may be roughly subdivided as follows: (1) several introductory chapters containing some sketches of scientists and some of the basic ideas of atomic particles and radiation; (2) recent developments in electronics (such as electronic calculator, dielectric heating, electron microscope, radar, and television); (3) spectacular gadgets and discoveries in nuclear physics (such as synchrocyclotron, betatron, linear accelerator, nuclear fission,

and isotopes); (4) concluding chapters on present and future sources of energy.

Although necessary technical terms are used, the book is on the whole clearly written, in nontechnical language, and is intended for the better-than-average reader. The facts presented are unusually accurate, and even the theoretical explanations—although frequently anthropomorphic—are only occasionally misleading. However, even to the "alert reader" (the author's words) to whom the book is addressed, the content is by no means light reading. Here and there he must interpret or dismiss statements of the following caliber: "The tube itself acts as a valve that allows energy to be pumped into a resonant 'tank' circuit at the phase of the cycle it is wanted." Fortunately, the chapters are subdivided into relatively short sections so that a busy man may take it in convenient doses. About a hundred photographs, which are collectively placed in three groups, and the subject index are helpful.

The author has made a long stride forward in meeting our urgent need that the public be induced to appreciate some of the recent scientific developments that are already rocking the foundations of our social structure.

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SCIENCE AND ART

Music and Medicine. Dorothy M. Schullian and Max Schoen, Eds. x + 499 pp. Illus. $6.50. Schuman. New York. 1948.

THIS volume is a symposium of contributions collected by Dorothy M. Schullian, Curator of Rare Books at the Army Medical Library. It consists of sixteen contributions by recognized authorities in the respective fields covered. Among the titles are Music and Medicine among Primitive Peoples (Radin); Music and Medicine in Classical Antiquity (Meinecke); The Story of Tarantism (Sigerist); A Psychiatrist's Experience with Music as a Therapeutic Agent (Altshuler); Music in Hospitals (van de Wall); Music in Industry (Cardinell); and The Development of an Experimental Psychology of Music (Diserens).

In the chronological order of the development there is a striking decline in the intimacy of medicine and music. In primitive magic, they were practically one, but with the coming of historical and scientific approaches there has been a gradual process of isolation of the two disciplines up to the beginning of this century. Now there is a revival. The book is timely because we are now facing a scientific approach to the relationship.

The topics and authors are well selected, and the volume is well edited. Both specialists and the general reader will find the book scholarly and interesting.

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EYEWITNESS ACCOUNT

The American Iliad. The Epic Story of the Civil War as Narrated by Eyewitnesses and Contemporaries. Otto Eisenschiml and Ralph Newman. 720 pp. $5.00. Bobbs-Merrill. Indianapolis and New York. 1947.

DON'T think that all the towns in which they are still fighting the Civil War lie south of the Mason-Dixon line. Chicago plunges anew into that conflict with every meeting of its famed "Civil War Round Table." Dr. Eisenschiml and Mr. Newman are two of the most intrepid, and hence celebrated, members of that group. The former gained the public eye when his first book, *Why Was Lincoln Murdered?* suggested that perhaps Boston Corbett was aiming at the wrong man when he shot J. Wilkes Booth; he might have come closer to the real culprit if he had drawn a bead on Edwin M. Stanton. Mr. Newman is the proprietor of a Chicago bookstore named after Abraham Lincoln and has made a lifework of purveying Civil War books to a public which seems constantly to increase.

When they put this bulky volume together, Dr. Eisenschiml and Mr. Newman were following a simple but sound idea. Why not try to show the war as it looked to those who fought it, or lived through it? They accordingly laid down a pattern which treated each major battle and campaign (*a*) as it

seemed to a high-ranking officer on the Federal side; (*b*) as it seemed to a soldier in the ranks on the Federal side; (*c*) as it seemed to a contemporary civilian commentator on the Federal side; (*d*) (*e*) and (*f*) the same process repeated for the Confederate side. The result is a fairly comprehensive, pretty well-balanced, and usually lively outline of the war. It is not the war as Douglas S. Freeman or Lloyd Lewis sees it, and much less as our economic determinist historians of the present see it. Nevertheless, it is the war as its participants knew it. And that is something worth remembering.

The human reactions have not changed essentially in eighty years. The men on the battlefield still show the same symptoms of fear. The men in command still seem to their subordinates to make the same bullheaded and boneheaded blunders. There may have been more confusion among the fighting men during the second world war as to what they were fighting for than there was during the Civil War, but there was plenty of confusion in the earlier instance, as this volume shows. And did the South plunge into the conflict as recklessly, as heedless of the possible cost, as we have been told? Read this from the famous diary of the wife of Colonel James Chesnut, former senator from South Carolina, aide to General Beauregard during the attack on Fort Sumter:

> *April 12, 1861.* I do not pretend to go to sleep. How can I? If Anderson does not accept terms at four, the orders are, he shall be fired upon. I count four. St. Michael's bells chime out and I begin to hope. At half-past four the heavy booming of a cannon. I sprang out of bed, and on my knees prostrate I prayed as I never prayed before.
>
> There was a sound of stir all over the house, pattering of feet in the confusion. All seemed hurrying one way. I put on my double-gown and a shawl and went, too. It was to the housetop. The shells were bursting. In the dark I heard a man say, "Waste of ammunition." I knew my husband was rowing about in a boat somewhere in that dark bay, and that the shells were roofing it over, bursting toward the fort. . . .
>
> The women were wild there on the housetop. Prayers came from them, and imprecations from the men. . . . Pryor, of Virginia, spoke from the piazza of the Charleston Hotel. I asked what he said. An irreverent woman replied: "Oh, they all say the same thing, but he made great play with that long hair of his, which he is always tossing aside!"

The book is full of just such fascinating bits as this, but the total result is not as effective as it might have been. This is principally due, I think, to the fact that most of the commanding generals are quoted, not in the day of battle or immediately after, but in terms of the alibis they had worked out for their own generalship fifteen and twenty years after the war was over. If Eisenschiml and Newman had stuck to the "contemporary" pattern more consistently than they did, they would have produced a better book. Insofar as their pages present actual "eyewitness" testimony, set down before counsel for the defense had a chance to coach the witness, the outcome is fascinating.

PAUL HUTCHINSON

The Christian Century
Chicago, Illinois

COMMENTS AND CRITICISMS

BUNYAN'S BARROWS

It is rather surprising that a biologist would support the idea that a peculiar microrelief, locally called hog wallows, or Mima Mounds, has been created by the pocket gophers. To the best of my knowledge, gophers are not mound builders, and it is hardly conceivable, to say the least, that any animals that do not have a certain instinct would acquire it as soon as they move into an environment unfavorable to their normal behavior.

It is no less surprising that a soil scientist would state that "closer observation reveals currently active ground squirrels that have mounds as large as 40 feet in diameter and 10 feet in height" (SM, January 1948, 175). Ground squirrels occupy many of these mounds, so one may say that they "have" them, but the fact of occupancy does not by any means prove that the squirrels built the mounds. A little closer observation, probably, would suggest that the ground squirrels' work tends to flatten down the mounds rather than to build them up.

There are, perhaps, no less than a dozen different hypotheses about the origin of these mounds, and I cannot resist the temptation to add one more, so far not mentioned in any list. It is not mine. It was related to me some years ago by an old farmer in the San Joaquin Valley, who was much concerned with hog wallows because he had a hard time leveling his land for an orchard. I shall try to present his story as near as it was told to me while he allowed his team of mules to rest. Here is the story:

"Once upon a time a man by the name of Bunyan—Paul Bunyan—lived in this country. Whether it was Paul himself or one of his Western relations—I am not suite sure on this score. Anyhow, I gather that this man was quite a character and had some ideas not to be expected of an ordinary fellow.

"Whether Paul heard something about the Chinese Wall or not, he got his own idea about it and concluded that the United States needed a proper protection so as not to be taken too easily by our enemies. So, when he had thought this over to his satisfaction, Paul hired a bunch of Irishmen and directed them to build a great wall of our own.

"The Irishmen got wheelbarrows and set to work. For awhile, no doubt, they worked pretty hard, so that eventually quite a hole resulted on one side, from which they moved the dirt to the other side. In due time, this hole apparently became flooded almost to overflowing, and this was how the Pacific Ocean was created, notwithstanding other, scientific explanations. And the wall they were building, it's—look back of you—the Sierras. . . . Yes, brother, it's how things like these have developed, as the saying goes.

"Well, the work progressed quite satisfactorily for awhile, and Paul was very much pleased with the creation. Somewhat before its completion, however, the Irishmen began to complain about the victuals that Paul provided for them. It turned out that Paul disagreed with the boys and just paid no attention to their dissatisfaction. So the Irishmen talked it over and decided to go on strike.

"Well, when Irishmen get an idea, they take it seriously. That's where Paul, probably, miscalculated. . . . They turned over their wheelbarrows, dumped the dirt all over the country wherever they happened to be, and went back to Ireland. Now, apparently such a calamity happened years ago, so that nothing is left of the wheelbarrows to the extent that even the nails corroded beyond recognition; but heaps of dirt from each wheelbarrow are still with us. . . . And this is how the hog wallows came to be, brother."

Although quite a few of Paul Bunyan's magnificent deeds are generally known, to the best of my knowledge his sad experience with the Irishmen has not been recorded. So, perhaps, lovers of our folklore will be glad to add this story to their collection. And with regard to science—well, the Paul Bunyan story cannot hurt any that can stand on its own merit.

A skeptical reader will say that Paul Bunyan is a fiction, but, perhaps, so is the mound-building gopher—what is the difference?

C. C. NIKIFOROFF

University Park, Maryland

A GLACIAL REACTION

Because Professor Emeritus W. H. Hobbs so long ago originated the "glacial-anticyclone" theory (about 1911) and since then has had his own facts for the most part interpreted against him, it is uncommonly interesting to find him today charmingly proceeding as if the "glacial anticyclone" were a well-established feature of large ice sheets (SM, February 1948). Most informed opinion and many additional facts have steadily been marshaled in favor of alternative explanations for the nourishment of continental ice sheets. Today's fuller picture is that of storm (cyclonic circulation) nourishment by air masses traveling common tracks and by common orographic processes operating when air masses meet lofty obstructions.

The experience of meteorologists, geologists, and persons with wartime knowledge of Greenland, among others, simply does not bear out the "glacial anticyclone." Anyone interested in a full, cohesive, and lucid account of glacial phenomena might consult the very recent book by Professor Richard Foster Flint, of Yale, (*Glacial Geology and the Pleistocene Epoch*. N. Y.: Wiley. 1947), which cites the literature exhaustively. However, one need

not make a mere appeal to authority, for the article itself offers many items for critical review.

For instance, the continental ice sheet is pictured as nourished solely by ice needles from cirri of the central downdraft. Since cirrus clouds exist at altitudes up to 20,000 feet and more and, in the downdraft sketched by Hobbs, must come in from a region of great altitude and great cold where they simply cannot contain much moisture relatively, the mechanism is a dubious one. Singularly, continental ice sheets seem unable to accumulate much beyond 10,000 feet, even though cirrus clouds go much higher; on the other hand, 10,000 feet is approximately the altitude to which air masses on the average can reach and bring nourishment. The mystic 10,000 feet holds for Greenland as an order of magnitude, for Antarctica, and, probably, for the continental ice sheets of the past.

Around Greenland two main storm tracks are found: those coming upon the island from the SE and those from the SW. In either case they bring much moisture. Frequently, they are unable to surmount the ice barrier, but lap onto its flanks, and so are canalized into proceeding along the ice margin. As a result, not only is the greatest nourishment of the Greenland ice sheet in its southerly portion, but there also the ice stands at the highest altitude. Air masses have been so effectively robbed of their moisture by the time they reach northern Greenland that they have little to contribute; probably, even, after the manner that ice disappears from our winter roads though the temperature stays well below freezing, they pick up moisture by sublimation. The end result is that the far northern part of Greenland neither is ice-covered today nor shows any evidence of having ever been glaciated!

Undoubtedly, foehn-type winds may and do exist in Greenland. Dense, cold air equally may and does slide down a Sierra Nevada valley. Such winds are not invariable; they require appropriate conditions. It does not do to attribute to them transcending powers, particularly in the face of a well-established system of world air circulation and in the face of other evidence which the "glacial-anticyclone" concept by no means explains.

SANBORN PARTRIDGE
New Haven, Connecticut

P.S. Since writing the above letter, I have read a pertinent article by François E. Matthes, "The Glacial Anticyclone Theory Examined in the Light of Recent Meteorological Data from Greenland" (Pt. I: *Trans. Amer. Geophys. Union*, 1946, **27**(3), 324–41). Dr. Matthes never raises his voice, quietly cites the evidence, and applies sound, logical reasoning. I think that I have never seen an idea so thoroughly dissected, exposed, and found wanting as the "glacial anticyclone" at his hands.

THE SUBSTITOOTER

You have lately published some first-class advice on writing and public speaking. You may wish to pass on to your readers the following rules on how to give a guest lecture in a colleague's course. In our university we do a good deal of lecturing for each other. It may be that the same is true in other institutions of learning and in laboratories and industries where special courses are given on some new subject or problem that requires the collaboration of people in several specialties. If so, they may wish to profit from our experience.

HOW TO GIVE A GUEST LECTURE IN A COLLEAGUE'S COURSE

1. Assure your listeners that you haven't any idea what the course is about. This will convince them either that the people running the course didn't show you a syllabus, or that you didn't consider it important enough to look at. You will thus impart a proper idea of the respect in which colleagues hold one another, as well as of the nice, offhand lack of planning of courses.

2. Tell them that you really don't know what to say in "these few remarks." Then they will understand your doubts (duly expressed) about why you were asked to give the lecture.

3. When referring to any real or supposed differences of judgment between yourself and your colleagues, repeat frequently the phrase "in my humble opinion." For it is—unlike its mate, "I must confess my ignorance"—a phrase which is, of course, taken more seriously with each repetition. You will thus put any ensuing argument squarely on a personal basis, and you will also set yourself off clearly from your more arrogant colleagues.

4. Never fail to say that you can do nothing with so vast a subject as yours in so short a time. To demonstrate the truth of this, take ten minutes to get it said. Thus demonstrated, the statement will serve several of your dearest aims. It will make the students fully aware of your opinion of their intelligence. It will imply your notion of good pedagogy. It will prove your devotion to the scholar's leisurely disregard of time, especially of students' time.

5. To make sure that all the above sinks in, continue to talk for five minutes after the bell rings.

6. To make assurance doubly sure, bolt from the room before anyone can ask you a question.

I know that these rules are right, for they are followed by most of us on the faculty, and we are famous men. A few persistently disregard them. The results are astounding. The students talk of it for days.

EVERETT C. HUGHES
Division of the Social Sciences
The University of Chicago

Correction. Kurt W. Kohn and Walter J. Schneider, of The Bronx High School of Science, were among the forty prize winners in the Westinghouse Science Talent Search (The Brownstone Tower, May 1948).—Ed.

TECHNOLOGICAL NOTES

Better bone char. Many of the processes of industry are amazingly varied, and unsuspected by most of us. For instance, our 9 billion pounds of cane sugar are refined by a process that includes passing the syrup through immense filters of bone char, equal in weight to half the sugar produced. Of course 4.5 billion pounds of bone char do not exist at the same time; when the char no longer absorbs efficiently the spent material is revived by washing, drying, and heat. New char weighs about 40 pounds per cubic foot and is so porous that 100 pounds will have 2.25 square miles of surface area. In repeated use the pores clog and the char gains in weight. Bureau of Standards studies are pointed toward discovering ways to renew char with the smallest amount of waste—and, more important, to be able to predict the qualities of char as an adsorptive medium.

For enjoyment of salt. People who have dropsy may have to subsist on insipid diets, devoid of salt. One possible form of relief is to give the food savor with a mixture that tastes like salt but is free of sodium. Now the Permutit Company has a new method. During the war emergency kits contained resins that would make sea water potable by the ion-exchange process. The person who cannot stand salt may be able to enjoy his food in the usual way if he will take a generous dose of resin before and after meals.

Hunting iron in Minnesota. As the holes around Hibbing and other parts of Minnesota grow larger the iron ore reserves become smaller. Already there is talk of using leaner ores and of shifting to supplies from other parts of the world. But there may be rich deposits in Minnesota, buried under a thick blanket of glacial drift. The airborne magnetometer is being used in an effort to locate such bonanzas, if they exist. Minnesota and the U. S. Geological Survey are cooperating in this aerial prospecting. The device is flown over a grid course, making a continuous record of variations in the earth's magnetic field. Places where the magnetism is high will receive more detailed exploration on the ground.

No need to crowd. The number of persons who can have ringside seats to witness an operation is extremely limited. Television can increase the range. Northwestern University School of Medicine will make use of television to demonstrate surgical techniques to as many as 1,500 people at a time at the Chicago meeting of the American Medical Association June 21–25.

Heating and eating. Very cold weather may affect a limited food budget adversely. The tendency to eat heartily in cold snaps and to toy with food in warm weather has been confirmed and explained by Yale University researchers. The hypothalamus, heat regulator of the body, also has the say-so in deciding to eat and not to eat and when to quit. Nothing is said in the report about the tendency to take aboard too much food as a substitute for emotional satisfaction.

Appeal for invention. Quartz crystals, mostly imported from Brazil, are exceedingly important as radio frequency controls. A substitute for this purpose or a source of material inside the United States is called for in the *Journal of Economic Geology.*

Let there be light. From Hollywood or near it comes the triumph in application of scientific discoveries to modern gadgetry. Charles Tucker, of Los Angeles, has announced a table lamp that lights up when the word "Bright" is spoken with resonance.

Food from sawdust. When food is scarce the balance between grains used for food and for feed becomes delicate. Human beings have first claim. When that is the case, according to *Industrial and Engineering Chemistry,* sawdust may be made an important part of cattle feed. Chemical modification to remove the lignin and combination of the modified sawdust with sources of vitamins and minerals make a feed that is efficient and that, so far, is not in demand for human consumption. Paper pulp is another possible addition to cattle feed, but the present shortage of paper would seem to make that source of roughage unpromising.

M. W.

THE BROWNSTONE TOWER

DEAR MR. EDITOR-TO-BE:

THIS is my last message from The Brownstone Tower. The time has come for me to leave the SM and turn over its editorial direction to you. Not knowing your name as yet, I do not know how I can best help you, but I do want to encourage you at least.

You will take over a magazine that has been, since 1872, the chief medium of communication between American scientists and the educated public. With the increase of specialization in science, the importance of the SM has grown as a means for broadening the scientific outlook of scientists. The busy specialist who takes the SM can emerge from his diggings once a month for a view through its pages of the scientific world outside his own mine. You may feel that the view he has been getting is imperfect, and you will probably want to make it more comprehensive, understandable, interesting, or authoritative. You would not be a good editor if you did not see the need and opportunity for improvement.

You should not worry too much about format; it is the subject matter of the magazine that will make or break it. You will be dependent on manuscripts contributed by scientists. Without solicitation you will get more than enough manuscripts to fill the SM, but for various reasons related to your policy you will not publish a large proportion of those you receive. You will quickly find that solicitation of manuscripts is essential for the improvement of the contents of the magazine, and you will be successful to the extent that you can persuade busy scientists of reputation to write for the SM in an interesting, nontechnical fashion. You must become a salesman with the objective of convincing scientists who have something to say to a general audience that they should take the time and trouble to write it for the SM. You will have arrived when any scientist will give top priority to your invitation.

If you have not been a professional scientist, you may wonder with what manner of men you must deal, but you will soon discover that they are both human and humane. Upon request they will draw freely upon their time to give you advice, and your letters of solicitation will almost always bring prompt, courteous, and sympathetic replies. You will find that most scientists will want to write for the SM, and you will get many promises, some unconditional, and others carrying various reservations. But remember that a manuscript in hand is worth a flock of promises. Unfortunately, scientists are often overoptimistic about their capacity to perform, and deadlines seem not to mean as much to them as they do to you. When you fail to get a manuscript at the predicted time—and that is the rule, not the exception—you should write repeatedly at reasonable intervals and make personal contacts if you can. Courteous patience will win, though it may take years to get a manuscript you want, for, as one potential contributor expressed it, "I'm sure that next time it will be easier to do the article than explain why I can't."

You will have little trouble with the writers of accepted manuscripts. Most will be grateful for your editorial suggestions and for careful copy editing and checking of facts. It is not easy to maintain a nice balance between your responsibilities to your contributors and those to your readers, but I think the readers must always be given the benefit of a doubt. Samples of readers might be polled now and then to find out how you are doing and you might modify your policies accordingly. Caustic comments on the articles you publish will be sent to you, whereas most bouquets will be sent directly to the authors. Your critics will not hurt you, but will merely spur you on to greater efforts. Your greatest satisfaction may come from the friendly contacts you will establish with some contributors and readers.

Whatever the future brings, hold to the principle that the A.A.A.S. must provide, through the SM or otherwise, a means of broadening communication among scientists in different fields. Go ahead, then, with confidence and enthusiasm!

Sincerely yours,

F. L. CAMPBELL

INDEX

CONTRIBUTORS

Principal Articles

BAKKE, E. WIGHT: Teamwork in Industry, 213.
BLACK, MAX: Principles of Really Sound Thinking, 232.
BLAKESLEE, ALBERT F.: Edmund Ware Sinnott, 5; Impressions of India, 141.
BRAND, CHARLES J.: The National Fertilizer Association, 33.

CAMERON, STELLA B.: Moses in the Laboratory, 488.

DAVIS, H. M.: Liberal Education and the Physical Sciences, 421.
DAVIS, W. A., and HAVIGHURST, R. J.: The Measurement of Mental Systems, 301.
DRAGSTEDT, CARL A.: Intravenous Injections, 25.

ELLIS, ALBERT: The Application of Scientific Principles to Scientific Publications, 427.
ENSIGN, GEORGE G.: Time, 206.
ERIKSSON, HERMAN: The Nobel Prizes, 363.
ESSIG, E. O.: The *Ruppia* Balls of Little Borax Lake, 467.
EVANS, L. H.: The Library of Congress as the National Library of Science, 405.

FERGUSON, IRA L.: Contact Lenses, 491.
FISH, F. F.: The Return of Blueback Salmon to the Columbia River, 283.

HARDING, HAROLD F.: The Principles of Poor Speaking, 54.
HARRINGTON, E. R.: Black Butte, a Recent Subsidence Crater, 461.
HAVIGHURST, R. J.: *See* DAVIS, W. A.
HENRY, JULES: Cultural Discontinuity and the Shadow of the Past, 248.
HIRSH, JOSEPH: *De Spiriti*, or History Is Right, 402.
HOBBS, WILLIAM HERBERT: American and Eurasian Glaciers of the Past: A Picture Based on Existing Ones, 99.
HODGE, W. H.: Agricultural Education in Colombia, 91.
HUTCHENS, JOHN O.: The Tox Lab, 107.

JENKINS, M. D.: The Upper Limit of Ability among American Negroes, 399.
JENSSEN, WARD: *See* SEASHORE, ROBERT H.

KELLER, W. D.: Native Rocks and Minerals as Fertilizers, 122.
KELLOGG, CHARLES E.: Conflicting Doctrines About Soils, 475.
KOONS, FREDERICK C.: The Sand Mounds of Louisiana and Texas, 297.
KROGMAN, WILTON MARION: Physical Anthropology and Race Relations: A Biosocial Evaluation, 317.

LACY, DAN MABRY: International Cultural Cooperation, 418.
LAPHAM, MACY H.: The Desert Storehouse, 451.
LEWIS, OSCAR: Rural Cross Section, 327.
LINDSEY, ARTHUR WARD: The Faith of Science, 395.

MCDONALD, THOMAS H.: Improved Methods of Transport and Their Significance, 57.
MCINTIRE, ROSS T.: For Now and the Future, 135.
MALAMUD, DANIEL: The Counselor Says "M-hm," 145.
MANLEY, J. H.: One Atom and Many, 47.
MAYALL, N. U.: Nature's Greatest Explosions: Supernovae, 17.
MILLER, BENJAMIN F.: Group Medical Practice, 389.
MILNE, LORUS J., and MILNE, MARGERY J.: The Life of the Water Film, 113.

OEHSER, PAUL H.: George Brown Goode (1851–1896), 195.

PALMER, ARCHIE M.: Patents and University Research, 149.
PEARSON, OLIVER P.: Metabolism and Bioenergetics, 131.
PENROSE, EDITH TILTON: A Great African Project, 322.
PERRY, J. W.: The Utilization of Scientific Knowledge, 413.
PÉWÉ, TROY L.: Origin of the Mima Mounds, 293.

RADER, MELVIN: Technology and Community: The Mandates of Survival, 502.
RIKER, A. J., *et al.*: Advice to Newcomers: A Report on Releasing the Results of Research to the Public, 499.

SEASHORE, ROBERT H., and JENSSEN, W.: Personality Classification and Counseling Techniques, 472.
SKUTCH, ALEXANDER F.: Life's Greatest Evil, 514.
STUART, NEIL W.: Growing Plants Without Soil, 273.
SUBARSKY, ZACHARIAH: What is Science Talent? 377.
SUTER, RUFUS: Salomon's House: A Study of Francis Bacon, 62.

VISHER, STEPHEN S.: Thunderstorms, 335.

WEDDERBURN, ALEXANDER J.: Photography in Science, 9.
WHITE, LESLIE A.: Man's Control over Civilization: An Anthropocentric Illusion, 235.
WILKINSON, FORD L., JR.: The U. S. Naval Postgraduate School, 183.
WOLF, RALPH F.: Eighty-eight Years of Synthetic Rubber, 221.

Science on the March

BEAMS, J. W.: Centrifugal Fields, 255.

CHESTER, K. STARR: Plant Protection Mutates, 157.

HUFFMAN, C. F.: The Role of the Rumen in the Nutrition of the Ruminant, 342.

LURIA, S. E.: Sex in Bacteria and Viruses, 159.

OCHSE, J. J.: Experience Is Their Laboratory, 70.
OLIVE, LINDSAY S.: The Nuclear Cycle in the Fungi, 444.

RICHTER, CHARLES F.: International Recovery in Seismology, 67.
RUSSELL, JOHN A.: Meteorites: Comet Components, 519.

Book Reviews

(Indexed By Reviewers)

AGINSKY, ETHEL G.: *The Indians of the Americas,* by John Collier, 351.
ATWOOD, WALLACE W.: *Outlines of the Geography, Life and Customs of Newfoundland-Labrador,* by V. Tanner, 259.

BALL, CARLETON R.: *Two Blades of Grass,* by T. Swann Harding, 75.
BELL, E. T.: *Whom the Gods Love. The Story of Evariste Galois,* by Leopold Infeld, 431.
BERLIN, RICHARD B.: *Duncan of Liverpool,* by W. M. Frazer, 171.
BERRY, CHARLES T.: *A Field Guide to the Shells of our Atlantic Coast,* by P. A. Morris, 262.
BUSS, FRANCES: *Television Techniques,* by Hoyland Bettinger, 163.
BYERLY, PERRY: *When the Earth Quakes,* by James B. Macelwane, 165.

CARLSON, A. J.: *What Is Life?,* by J. B. S. Haldane, 442; *Education for What is Real,* by Earl C. Kelley, 442.
COBEY, MILTON C.: *The Back and its Disorders,* by Philip Lewin, 526.
COFER, CHARLES N.: *Hypnotism Today,* by Leslie M. LeCron and Jean Bordeaux, 168; *Current Trends in Psychology,* by Wayne Dennis *et al.,* 265; *Conceptions of Modern Psychiatry,* by Harry Stack Sullivan, 352.
COLLINS, HENRY B., JR.: *Bridge to Russia,* by Murray C. Morgan, 352.
CRAWFORD, W. REX: *The Theory of Social and Economic Organization,* by Max Weber, 163.

DALE, EDGAR: *From Caligari to Hitler,* by Siegfried Kracauer, 80.
DEICHMANN, ELISABETH: *Naturforskeren Johannes Schmidt.* øjvind Winge and Å. Vedel Tåning, Eds., 73.
DUBOIS, W. E. B.: *Ideas Have Consequences,* by Richard M. Weaver, 432.

FARNSWORTH, ALICE H.: *The Naming of the Telescope,* by Edward Rosen, 264.
FENTON, WILLIAM N.: *Chippewa Village,* by W. Vernon Kinietz, 263.
FISCHER, ERIC: *The Geographical Names of Antarctica.* U. S. Board on Geographical Names, Dept. of the Interior, 170.
FREEMAN, IRA M.: *The Scientists Speak.* Warren Weaver, Ed., 350.

GARDNER, THOMAS S.: *Rockets and Space Travel,* by Willy Ley, 78.
GRANT, CHAPMAN: *Amphibians and Reptiles of the Pacific States,* by Gayle Pickwell, 166.
GRAUER, BEN: *Maya Explorer,* by Victor Wolfgang von Hagen, 435.

HANNAFORD, EARLE S.: *Surveying Instruments,* by Edmond R. Kiely, 347.
HART, DERYL: *George Crile, An Autobiography.* Grace Crile, Ed., 524.
HAWLEY, J. H.: *Alexander Dallas Bache,* by Merle M. Odgers, 438.
HAYES, H. K.: *The Hybrid-Corn Makers,* by A. Richard Crabb, 438.
HEDGPETH, J. W.: *English Naturalists from Neckam to Ray,* by Charles E. Raven, 353.
HENDRICKS, B. CLIFFORD: *Alsos,* by Samuel A. Goudsmit, 346.
HUTCHINSON, PAUL: *The American Iliad,* by Otto Eisenschiml and Ralph G. Newman, 529.

INFELD, LEOPOLD: *One Two Three . . . Infinity,* by George Gamow, 440.

JENKINS, MARTIN D.: *The Gifted Child Grows Up,* by Lewis M. Terman and Melita H. Oden, 527.

KENNEDY, JOHN L.: *The Reach of the Mind,* by J. B. Rhine, 167.
KROGMAN, W. M.: *Men Out of Asia,* by Harold Sterling Gladwin, 437.

LASKY, JESSE L.: *Magic Shadows,* by Martin Quigley, Jr., 431.
LEHNER, GEORGE F. J.: *Personality,* by Gardner Murphy, 168; *400 Years of a Doctor's Life,* by George Rosen and Beate Caspari-Rosen, 442.
LINDSAY, J. R.: *Hearing and Deafness.* Hallowell Davis, Ed., 355.
LINDSTROM, ERNEST W.: *Genetics, Medicine, and Man,* by H. J. Muller, C. C. Little, and Laurence H. Snyder, 78.
LINTON, RALPH: *Family and Civilization,* by Carle C. Zimmerman, 439.

MCHENRY, DONALD EDWARD: *East of the Andes and West of Nowhere,* by Nancy Bell Bates, 266.
MCMILLEN, ROBERT D.: *Cache Lake Country,* by John J. Rowlands, 440.
MANN, WILLIAM M.: *A Multitude of Living Things,* by Lorus J. Milne and Margery J. Milne, 77; *One Day at Teton Marsh,* by Sally Carrighar, 263.
MASON, HOWARD S.: *Science in Progress.* George A. Baitsell, Ed., 169.
MERRILL, PAUL W.: *John Couch Adams and the discovery of Neptune,* by Sir Harold Spencer Jones, 77; *The Life and Times of Tycho Brahe,* by John Allyne Gade, 436.

METZNER, CHARLES A.: *Say It with Figures,* by Hans Zeisel, 76.
MILLER, BENJAMIN F.: *Private Enterprise or Government in Medicine,* by Louis Hopewell Bauer, 523.
MILNE, LORUS J., and MILNE, MARGERY J.: *Insects and Human Welfare,* by Charles T. Brues, 441.
MYERS, W. M.: *A Scientist with Perry in Japan.* Allan B. Cole, Ed., 433.

NICHOLSON, SETH B.: *Sunspots in Action,* by Harlan True Stetson, 265.

OEHSER, PAUL H.: *Louis Agassiz, Scientist and Teacher,* by James David Teller, 350; *Breaking New Ground,* by Gifford Pinchot, 443.
OLD, BRUCE S.: *Combat Scientists,* by Lincoln R. Thiesmeyer and John E. Burchard, 348.

PAGE, ROBERT M.: *New Weapons for Air Warfare.* Joseph C. Boyce, Ed., 345.

RHINE, J. B.: *Telepathy and Medical Psychology,* by Jan Ehrenwald, 525.
ROBINSON, G. D.: *Causes of Catastrophe,* by L. Don Leet, 526.

SEASHORE, CARL E.: *Music and Medicine.* Dorothy M. Schullian and Max Schoen, Eds., 529.
STIEGLITZ, EDWARD J.: *The Years After Fifty,* by Wingate Johnson, 264; *Medical Aspects of Growing Old,* by A. T. Todd, 264.
SUMNER, F. C.: *Doctor Freud,* by Emil Ludwig, 436.

THOMPSON, RICHARD K., JR.: *Your Teeth and How to Keep Them,* by Jerome J. Miller, 525.

VARGAS, OSCAR: *English-Spanish Chemical and Medical Dictionary,* by Morris Goldberg, 167.
VOLD, ROBERT D.: *Small Wonder: The Story of Colloids,* by Gessner G. Hawley, 348.

WATANABE, KINICHI: *Energy Unlimited,* by Harry M. Davis, 528.
WEBER, ROBERT L.: *What Electronics Does,* by Vin Zeluff and John Markus, 523.
WEKSTEIN, LOUIS: *In Search of Beauty in Music,* by Carl E. Seashore, 74.
WHALEY, W. GORDON: *Our Flowering World,* by Rutherford Platt, 353.
WILCOX, E. V.: *The Story of Water Supply,* by F. W. Robins, 79; *Science in Farming.* Alfred Stefferud, Ed., 262; *Fish Ponds for the Farm,* by Frank C. Edminster, 354; *Liberia,* by Charles Morrow Wilson, 434.
WOOLFOLK, E. J.: *Birds of Malaysia,* by Jean Delacour, 171.

Verse

BOLLES, LAURENS C.: Lines to a Skyscraper, 460.

ERICSSON, EMILY: Two Squares of Glass, 417.

GOFF, ERIS: Where Silence Sings, 321; The Aurora, 466.
GOODMAN, MAE WINKLER: Texture of Snow, 56; Arctic Tern, 234; Telescope on Mount Palomar, 376.

HIRSH, JOSEPH: The Weatherman, 282; Twisted Trees, 498.

JOHNSON, PAUL B.: The Roads, 140.

LONGFELLOW, ISABELLE BRYANS: The Gray Edge, 398; Weather Is Like Wild Horses, 471.

MILLER, J. S.: On the Death of a Willow in the Hurricane, 341.
MONAHAN, THOMAS P.: For We Are One, 487.

O'BRIEN, KATHARINE: Well of Desolation, 247.

SINCLAIR, JOHN G.: Ameba, 334.

ZAHNISER, HOWARD: America Grows Corn, 383.

Comments and Criticisms

ABBOT, CHARLES G.: Re Rhine, 358.
ARKLEY, RODNEY J.: The Mima Mounds, 175.

CAHN, HERBERT: Last Word On Garrett, 447.
CAMPBELL, F. L.: The Brownstone Tower, 90, 179, 272, 361, 450, 534.

DAVIDSON, HAROLD B.: Vital Statistics, 358.
DORCHESTER, FRANK E.: Shakespeare's Physiology, 270.
DUDLEY, J. WHITNEY: San Joaquin Valley Hog Wallows, 356.

GRANT, CHAPMAN: Crumbling Rocks, 88.

HARWOOD, PAUL D.: Honeybees and Red Clover, 177.
HUGHES, EVERETT C.: The Substitooter, 532.
HUGHES, HELEN MACGILL: National Dog Week, 173.

KALICHEVSKY, V. A.: More on Man, the Myth-Maker, 357.
KELLY, ALLAN O.: Crumbling Rocks, 88; The Mima Mounds, 174.

LEVINE, NORMAN D.: Viviparity, 358.
LORD, LINDSAY: Modern Housing, 176.
LYFORD, C. ALLAN: To Ajax, 357; One Man's Meat, 447.
LYMAN, JOHN: The Sea's Phantom Bottom, 87.

MILLER, E. C. L.: Man, the Myth-Maker, 83.
MONTAGU, M. F. ASHLEY: Racial Intelligence, 81.

NEWBERRY, WILLIAM: Natural Resources, 176.
NIKIFOROFF, C. C.: Bunyan's Barrows, 531.

OKUN, DANIEL A.: Racial Intelligence, 173.

PARTRIDGE, SANBORN: A Glacial Reaction, 531.
PASAMANICK, BENJ.: Racial Intelligence, 82.
PRESTON, F. W.: Bridgman and Cohen, 83.

REICHARD, J. D.: The Mudfog Association, 174.

SAMACHSON, JOSEPH: Racial Intelligence, 173.
SPILLMAN, RAMSAY: On Comments and Criticisms, 267.
STALLINGS, J. H.: The Mima Mounds, 269.
STEARN, JOHN T.: Einstein's Error? 85.
STEINMETZ, HARRY C.: Obfuscating Personality, 87.
STEINOUR, HAROLD H.: Clotho, Lachesis, and Atropos, 447.

TAYLOR, WM. PALMER: Scientists and Social Problems, 267.
TODD, ARTHUR J.: Man, the Myth-Maker, 82.

WEED, MERRILL: Technological Notes, 89, 271, 359, 499, 533.

SUBJECT INDEX

Principal Articles

Agriculture (W. H. HODGE), 91; (N. W. STUART), 273; (E. T. PENROSE), 322.
Alcoholism (J. HIRSH), 402.
Anthropology (W. M. KROGMAN), 317.
Atom bomb (J. H. MANLEY), 47.

Bacon, Francis (R. SUTER), 62.
Bell County, Texas (O. LEWIS), 327.
Bibliographic citations, form of (A. ELLIS), 427.
Bioenergetics (O. P. PEARSON), 131.
Blood transfusions (R. T. MCINTIRE), 135.

Chemistry (J. O. HUTCHENS), 107.

Desert flora (M. H. LAPHAM), 451.
Drugs (C. A. DRAGSTEDT), 25.

Fertilizers (C. J. BRAND), 33; (W. D. KELLER), 122; (C. E. KELLOGG), 475.
Fish and Wildlife Service (F. F. FISH), 283.

Geology (E. R. HARRINGTON), 461.
Glaciers (W. H. HOBBS), 99.
Group medicine (B. F. MILLER), 389.

History of science (C. A. DRAGSTEDT), 25; (J. H. MANLEY), 47; (P. H. OEHSER), 195; (R. F. WOLF), 221; (N. W. STUART), 273.
Hydroponics (N. W. STUART), 273.

India, science in (A. F. BLAKESLEE), 141.

Labor relations (E. W. BAKKE), 213.

Mental tests (W. A. DAVIS and R. J. HAVIGHURST), 301; (M. D. JENKINS), 399.
Mima Mounds (T. L. PÉWÉ), 293; (F. C. KOONS), 297.

National Library of Science (L. H. EVANS), 405.
Negro intelligence (M. D. JENKINS), 399.
Nobel prizes (H. ERIKSSON), 363.
Nuclear physics (J. H. MANLEY), 47.

Ophthalmology (I. L. FERGUSON), 491.

Patents (A. M. PALMER), 149.
Peanuts (E. T. PENROSE), 322.
Philosophy (M. RADER), 502; (A. F. SKUTCH), 514.
Photography in Science (A. J. WEDDERBURN), 9; Second Salon, 180.
Postgraduate School, Navy (F. L. WILKINSON, JR.), 183.
Problem solving (W. A. DAVIS and R. J. HAVINGHURST), 301; (R. H. SEASHORE and W. JENSSEN), 472.
Psychiatry (D. MALAMUD), 145.
Public speaking (H. F. HARDING), 54.
Punched-Card Committee, A.C.S. (J. W. PERRY), 413.

Race relations (W. M. KROGMAN), 317.
Reading list, scientific (H. M. DAVIS), 421.
Red Cross (R. T. MCINTIRE), 135.
Rubber, synthetic (R. F. WOLF), 221.
Ruppia Maritima L. (E. O. ESSIG), 467.

Salmon fisheries (F. F. FISH), 283.
Science and religion (A. W. LINDSEY), 395.
Science talent (Z. SUBARSKY), 377.
Sinnott, Edmund Ware (A. F. BLAKESLEE), 5.
Smith-Mundt Act (D. M. LACY), 418.
Smithsonian Institution (P. H. OEHSER), 195.
Sociology (L. A. WHITE), 235; (J. HENRY), 248; (O. LEWIS), 327.
Soilless plant culture (N. W. STUART), 273.
Soil science (C. E. KELLOGG), 475.
Sound thinking (M. BLACK), 232.
Supernovae (N. U. MAYALL), 17.

Toxicity Laboratory, University of Chicago (J. O. HUTCHENS), 107.
Transportation (T. H. MACDONALD), 57.

U. S. Book Exchange (D. M. LACY), 418.

Weather (S. S. VISHER), 335.

Xenopus laevis (S. B. CAMERON), 488.

Zoology (L. J. and M. J. MILNE), 113.

Science on the March

Bacteria and viruses, genetics of (S. E. LURIA), 159.

Centrifugation, high-speed (J. W. BEAMS), 255.
Cytology (L. S. OLIVE), 444.

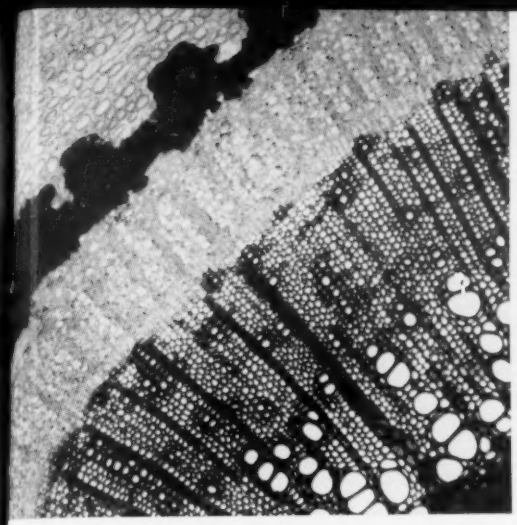
Fungicides (K. S. CHESTER), 157.

Meteorites (J. A. RUSSELL), 519.

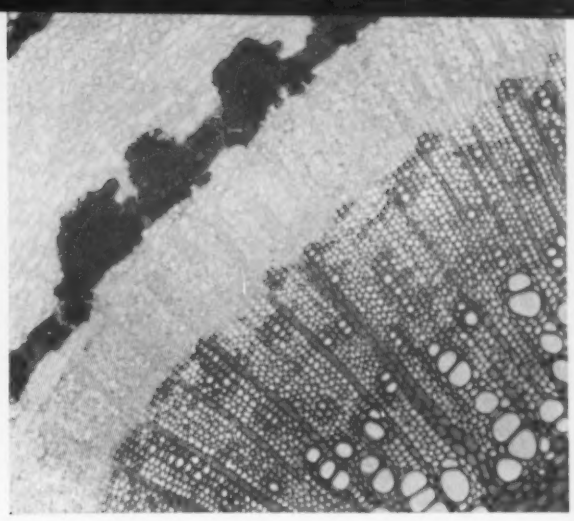
Nutrition of ruminants (C. F. HUFFMAN), 342.

Seismology (C. F. RICHTER), 67.

Tropical flora (J. J. OCHSE), 70.



Cross-section of ash stem at X75. Light bands are stained green and darker areas red. Photographed on Kodak Metallographic Plate to emphasize red-stained structures.



Same subject photographed on Kodak Wratten "M" Plate. Note that more detail is now visible in red-stained structures but their contrast to the green-stained structures is less.

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Ortho	16	20	Wratten Metallographic (D-19)	2	85	8	10	Contrast Process Ortho	1	120
Ordinary	4	3	Kodak Process	1	70					
MEDIUM CONTRAST—HIGH RESOLVING POWER										
Pan	2	40	Wratten Panchromatic (B)	3	55	20	400	Super Panchro-Press Type B	3	50
Ortho	2	40	Kodak Commercial	2	60	10	200	Super Ortho-Press	2	45
Ordinary	1.2	20	Kodak 33	1	45	1.2	25	Commercial	1	50
EXTREME SPEED										
Pan		320	Kodak Super Panchro-Press (C)	3	45		500	Tri-X Pan (C)	3	40
Ortho		200	Kodak Super-Ortho Press	2	45		250	Ortho-X	2	40
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